FIRE COMMAND 1A

Approved by the Statewide Training and Education Advisory Committee

Adopted by the State Board of Fire Services

STUDENT MANUAL

1995 Edition

California Department of Forestry and Fire Protection

State Fire Training

FIRE COMMAND 1A

COMMAND PRINCIPLES FOR COMPANY OFFICERS

STUDENT MANUAL

Published by

STATE FIRE TRAINING
PO Box 944246
Sacramento, CA 94244-2460

April 1995 Edition

Table of Contents

State Fire Training

Mission Statement

The mission of State Fire Training is to enable the California fire service to safely protect life and property through education, training, and certification.

California Fire Service Training and Education System

The California Fire Service Training and Education System (CFSTES) was established to provide a single statewide focus for fire service training in California. CFSTES is a composite of all the elements that contribute to the development, delivery, and administration of training for the California Fire Service. The authority for the central coordination of this effort is vested in the Training Division of the California State Fire Marshal's Office with oversight provided by the State Board of Fire Services.

The role of CFSTES is one of facilitating, coordinating, and assisting in the development and implementation of standards and certification for the California fire service. CFSTES manages the California Fire Academy System by providing standardized curriculum and tests; accredited courses leading to certification; approved standardized training programs for local and regional delivery; administering the certification system; and publishing Career Development Guides, Instructors Guides, Student Manuals, Student Supplements, and other related support materials.

This system is as successful and effective as the people involved in it are. It is a fire service system developed by the fire service, for the fire service... and we believe it is the best one in the country.

Acknowledgments

The State Fire Training Curriculum Development Division coordinated the development of the material contained in this guide. Before its publication, the Statewide Training and Education Advisory Committee (STEAC) and the State Board of Fire Services (SBFS) approved this guide. This guide is appropriate for fire service personnel and for personnel in related occupations that are pursuing State Fire Training certification.

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Special acknowledgement and thanks are extended to the following members of CDF/State Fire Training Curriculum Development Division for their diligent efforts and contributions that made the final publication of this document possible.

The material contained in this document was compiled and organized through the cooperative effort of numerous professionals within, and associated with, the California fire service. We gratefully acknowledge these individuals who served as principal developers for this document.

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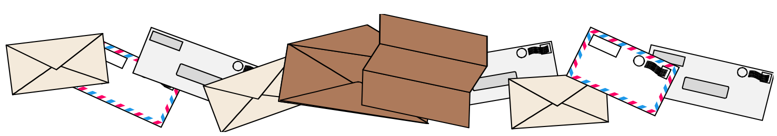
Introduction to the Manual

This publication is intended to serve as a student manual and includes information for a complete understanding of the topic with applicable activities. Appendices may be added as necessary to meet minimum course requirements.



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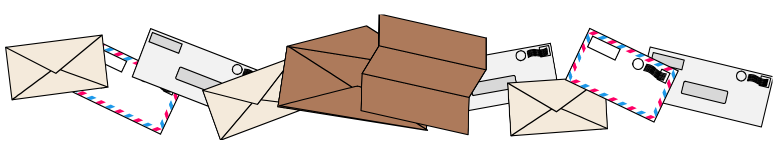


Course Outline

Course Objectives: To provide the student with…

- An introduction to human resource management.
- An overview of the organizational structure used within the fire service, including duties and responsibilities.
- An introduction to communication skills appropriate for reporting on conditions and managing resources at an emergency scene.
- Information on how to compile a prefire plan and how to utilize that information when responding to an emergency incident.
- The opportunity to size-up emergencies and identify the strategies, tactics and methods necessary to manage given scenarios.
- An overview of the common causes of fire fighter deaths and injuries, and appropriate safety measures to protect personnel.

Course Content: 40:00

1. Orientation and Administration...1:30
2. The Learning Process 0:15
3. Fire Command Overview 0:30
4. Fire Chemistry..0:30
5. Fire Phases 0:45
6. Effects of Time...0:30
7. Fire Behavior within Structures 0:30
8. Extinguishing Agents 0:30
9. Water Application 0:45
10. Protection Systems 1:00
11. Building Construction 0:45
12. Occupancy Types 0:15
13. Prefire Planning..0:30
14. Fire Data...0:15
15. Local Resources 0:15
16. State and Federal Resources 0:15

Topic 1: Orientation and Administration

Course Goals

This course is designed to provide the students with the following:

- An introduction to human resource management.
- An overview of the organizational structure used within the fire service, including duties and responsibilities.
- A review of communication skills appropriate for reporting on conditions and managing resources at an emergency scene.
- Information on how to compile a prefire plan and how to utilize that information when responding to an emergency incident.
- An opportunity to size-up emergencies and identify the strategies, tactics, and methods necessary to manage given scenarios.
- An overview of the common causes of fire fighter deaths and injuries, and appropriate safety measures to protect personnel.

NFPA 1021, Standard for Fire Officer Professional Qualifications

The Fire Command 1A curriculum encompasses a great number of subjects, skills, and goals geared towards structural fire fighting. This curriculum addresses, either partially or in full, the following requirements from NFPA 1021, Standard for Fire Officer Professional Qualifications, 1992 Edition. It includes requirements at Fire Officer Level I (Sections 2-2 through 2.13), Fire Officer Level II (Sections 3-2 through 3-13), and Fire Officer Level III (Sections 4-2 through 4-13).

Standard	Description
2-2:	**Human Resource Management**
2-2.2	Differentiate between the types of verbal orders or commands that an officer would use in each of the following situations: (a) During an emergency operation (b) While working in the station (c) During a training session
2-2.6	Demonstrate the ability to plan, assign, coordinate activities, and establish priorities at the unit level, given the job requirements of subordinate positions.
2-4:	**Organizational Structure**
2-4.1	Identify the authority and responsibility of each component of the fire department. Given a table of organization for the fire department, include lines of authority and the duties and responsibilities of each rank in both line and staff functions.

2-4.2 Identify the duties and command responsibilities of fireground officers using the incident management procedures adopted by the authority having jurisdiction at each of the following resource levels:

(a) A single unit response
(b) A multi unit response
(c) A major incident involving multiple units responding at various times

2-8:................Communication Skills. Complete a narrative report detailing both an emergency and a nonemergency incident.

2-10:...............Planning. Prepare an pre-incident plan that identifies hazards for each of the following occupancies:

(a) Assembly
(b) Educational
(c) Residential

2-11:...............Inspection, Investigation, and Public Education

2-11.2 Demonstrate methods used to identify and preserve evidence and secure a fire scene.

2-12:...............Emergency Service Delivery

2-12.1 Identify the factors that must be considered during a size-up to determine procedures for control of an emergency situation, given an incident.

2-12.2 Given an interior fire situation:

(a) Describe how the fire may extend within the building
(b) Describe how to control the spread of fire within the building

2-12.3 Given an exterior fire situation:

(a) Evaluate the situation
(b) Describe how to control the spread of the fire to keep it from extending to adjacent buildings

2-12.4 Identify the attack procedures required to control, confine, and extinguish fires in each of the following situations, if typical, within the authority having jurisdiction:

(a) Structures
(b) Flammable liquids
(c) Flammable gases
(d) Hazardous materials
(e) Exterior wildland

2-13:...............Safety

2-13.1 Identify the most common causes of personal injury to the fire fighter.

3-7:................Government Structure

3-7.1 Identify the functions of other bureaus, agencies, and divisions of government and the need for interagency and intergovernmental cooperation.

3-10:..............Planning

3-10.1 Prepare a prefire plan for a given target hazard using forms, symbols, and maps prescribed by the authority having jurisdiction. Include elements describing the utilization of personnel, equipment and extinguishing agents.

3-10.2 Prepare an operational plan that identifies the required resources and safety considerations for the safe and successful control of an incident involving any of the following materials:

(a) Flammable liquids
(b) Flammable gases
(c) Poisons
(d) Explosives
(e) Radioactive materials
(f) Flammable solids
(g) Reactives
(h) Corrosives

3-11:..............Inspection, Investigation, and Public Education

3-11.4 Given water system reference materials:

(a) Describe the water supply facilities as they apply to fire department operations
(b) Identify the procedure for mapping auxiliary water supplies to supplement the normal system
(c) Differentiate between sewer and drainage lines

3-12:..............Emergency Service Delivery

3-12.1 Determine the resources required for control and demonstrate the assignment and placement of these resources for any of the following:

(a) Flammable liquids
(b) Flammable gases
(c) Poisons
(d) Explosives
(e) Radioactive materials
(f) Flammable solids
(g) Reactives
(h) Corrosives

4-11:...............Inspection, Investigation, and Public Education

4-11.4 Evaluate and identify the construction features that might contribute to the spread of fire, heat and smoke throughout the building or from one building to another, given fire inspection reports for each of the following occupancies:

(a) Public assembly
(b) Educational
  1. Residential
  2. Nonresidential
(c) Institutional
(d) Residential
(e) Stores and offices
(f) Basic industry
(g) Manufacturing
(h) Storage
(i) Special properties

4-12:...............Emergency Service Delivery

4-12.1 Analyze an emergency incident requiring multiple company operations to determine the resources required for control and demonstrate the assignment and placement of the resources.

4-12.2 Describe the principles of delegation of authority at an emergency incident.

Topic 2: The Learning Process

Good fireground commanders are all around us. We often watch them and wonder what their secret is. The truth is that there is no secret. These skills are learned though experience and education. That learning process must be understood in order to benefit others.

Knowledge and Experience

The learning process consists of a conscious effort to raise both one's base of knowledge and one's level of experience. Knowledge is that which is known, an inventory of facts. It is acquired through formal classes, reading or self study, and listening to others who share their knowledge.

Experience consists of the events or circumstances that one has lived through. Experience is gained by exposing oneself to situations, environments, problems, and circumstances. It is important to note that longevity is not always an accurate indicator of one's level of experience. One year's experience repeated 20 times is but one year of experience.

Knowledge and experience can be transferred. You can increase your knowledge by studying or listening to someone else's experiences. You can enhance your experience level by applying knowledge to an appropriate situation.

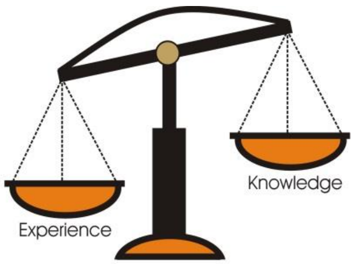
As a fire officer, you must be able to draw upon both knowledge and experience during many aspects of your job. Take, for example, a fire prevention inspection where you encounter code violations. Your knowledge of the codes, combined with your experience of actual fires, gives you more credibility and more confidence when trying to gain compliance from the building owner.

It is even more critical when you are faced with commanding a "once-in-a-lifetime" situation. Not many fire officers have experience commanding an aircraft crash because, fortunately, they do not happen that often. So, what can you do when so many lives are depending on you and you do not have a lot of time to formulate a game plan? You have to draw upon both knowledge and experience. Your knowledge base may include training in crash rescue, aircraft construction, Class B fuels, and extrication techniques. You have experience with Class B fires, application of foam, extrication, rescue, and first aid. You may have participated in mass casualty drills simulating aircraft crashes. A good fire officer utilizes both knowledge and experience as a foundation for making decisions in this new situation.

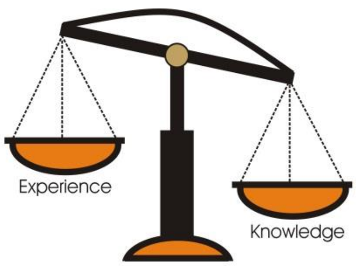
A Synergistic Balance

The best choice when selecting a fire officer is a person who has a good balance of experience and education. An officer with reasonably good education, but not much field experience, may be very "book smart." Yet, being able to perform well on written tests in the classroom is no guarantee that an officer is ready to make command decisions during the heat of battle. An officer with a lot of field experience, but little education, may be less confident in his or her decisions because they are based more on intuition than a solid foundation of formal training.

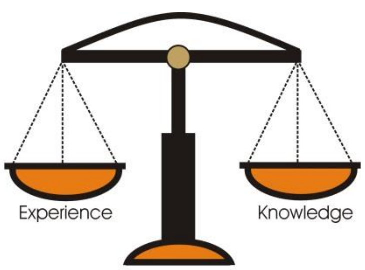
Figure #2.1: The Synergistic Balance



Little education, but reasonably high field experience.



Reasonably good education, but not much field experience.



Perfect combination of experience and education. Balance. The best choice in

Reinforcement

In order for learning to take place, experience and knowledge must build on one another. The key factor is positive reinforcement. Do not repeat behavior that brings about negative results. If you make mistakes, learn from them and move one. Learn from the mistakes of others. Most important, repeat the behaviors that bring success. Look at any successful athlete, musician, or professional in any field. They become successful by practicing repeatedly to improve their performance. It is no different in the fire service.

Summary

The learning process is a combination of both knowledge and experience and goes hand-in-hand, particularly on the fireground when we are often faced with new situations that require us to make the right decisions very quickly. The best fire officer is one who has a good balance of experience and education. Education can be acquired through formal training. But, experience comes from practice.

Review Questions

1. What is the difference between knowledge and experience?

2. How can knowledge and experience be transferred?

3. Why is a good balance of education and experience important?

4. What is the key factor in learning to apply education and experience?

5. List some examples in your own career where you have been able to successfully draw on both education and experience to handle a new situation.

Topic 3: Fire Command Overview

For many fire fighters, serving in a command position at a working fire is the high point of their career. Yet, others are reluctant to assume command at emergency scenes. Regardless of an officer's personal feelings, the command function is a basic responsibility of all line officers. This command function is made up of both specific activities and a human element. This chapter will provide you with an overview of both.

Why Command?

There are many reasons why people choose to advance to command positions. It is exciting to roll up to the scene of a major incident and know that you are in charge and the successful outcome of this incident is dependent on the decisions you make. It is exciting to be a part of the ranks of management where there are generally more opportunities to make a difference in the way things are done within the department.

Command is challenging. Fire officers need to know a lot more information and take on a lot more responsibility than they did when they were fire fighters. It certainly demands more time and dedication. Yet, many people thrive on that. Some people even choose command positions because they have some very strong "people" skills. They enjoy being in a position to help others develop.

On the other hand, command is not for everyone. Some people are just not suited to it. Other people may be very good in a command position, but at a later time in their lives. The first chapter addressed the importance of having a good balance of training (or knowledge) and experience as a foundation for command.

The other factor that comes into play is how each individual handles the responsibilities associated with command. It can add a lot of stress to someone's life. Some people just do not want that stress. Anyone who advances to a command position will occasionally experience a fear of failure. For some, that is just part of the challenge. They know that it is just a passing emotion, and that it makes the successes seem that much sweeter. Others are frequently held back by their own fear of failure. They avoid taking risks, including those that present opportunities for growth. Sometimes their fear of failure also holds back the people who work for them.

Often one of the most difficult adjustments for people who advance to command is the new relationship they have with the people around them. Sometimes new officers are no longer perceived as "one of the guys" by the fire fighters that they used to work with. They are now a supervisor: giving orders, evaluating performance, and looking out for "management" first. Sometimes new officers have the opposite problem. They are still perceived as "one of the guys" - almost as if nothing had changed. Fire fighters are often caught off guard when the new officer takes on command responsibilities because that is not what they are used to seeing from this individual. Either one of these situations can be uncomfortable for a new officer.

Since you are taking this class, it is reasonable to assume that you are seriously considering a command position. Or, perhaps you have already been promoted and are taking this class to become a better officer. Here are good questions for a fire officer to ponder occasionally. What is it that you find attractive about command? Which aspects are the most fulfilling to you? What strengths can you bring to the department as a fire officer? What are some of your fears or concerns? How might they impact your performance as a fire officer? What can you do to overcome those fears and concerns, and turn them into strengths instead?

Command Activities

The primary function of fire command is the systematic management of resources to reduce the impact of an emergency. To successfully carry out this function, the fire officer must engage in five general activities at every emergency:

- Collect and analyze facts
- Identify and assess probabilities
- Determine resource capabilities
- Make decisions
- Implement a plan

These activities where formalized into a process known as "size-up" by Lloyd Layman in his text, *"Fire Fighting Tactics."* These basic activities, as well as the primary function of resource management, do not change with the type of emergency or the rank of the officer in charge. Each of these will be discussed in more detail in subsequent chapters.

The Human Element of Command

While we define "command," as well as the functions and activities associated with it, in a very specific way, command is an endeavor involving human behavior. As such, it is subject to all the variances and flaws typical of humans.

There are two "givens" in command. First, no two individuals are likely to handle an emergency in the same manner. Each person's perception will be a little bit different. Each may size-up the situation differently. They will have different levels of training and experience. They may prioritize things differently, even when guided by set parameters or standard operating procedures (SOPs). And, rarely is there "one right answer."

The second "given" is that there is no such thing as the "perfect" fireground officer. At one time or another, all commanders will get excited or flustered, make mistakes or judgment errors, forget things, or doubt their abilities. They will often look back at an incident and think of things they could have done differently or better.

These are two important concepts. Acceptance of these two facts will better equip any officer to study the responsibilities and techniques of fire command.

Summary

There are a number of reasons why a person may choose a command position or choose not to advance to a command position. Nevertheless, when a person is in charge of an emergency, there are both specific command activities that must be accomplished and a human element that impacts the decision-making process. Acceptance of these two facts will better equip any officer to handle the responsibilities of command.

Chapter Review Questions

1. What are some reasons why people may choose to advance to a command position?

   ____
   ____
   ____

2. What are some reasons why people may choose ***not*** to advance to a command position?

   ____
   ____
   ____

3. What are the five general command activities that must be accomplished at every emergency?

   ____
   ____
   ____

4. What are the two "givens" in the human element of command?

   ____
   ____
   ____

Activity 3-1

TITLE:	Why Command?
INTRODUCTION:	An honest evaluation of your feelings can assist in becoming a better fire officer. This activity is designed to help you reflect on what you consider to be the advantages and disadvantages of command.
DIRECTIONS:	1. Answer each of the following questions.

1. What is it that you find attractive about command?

____

____

2. Which aspects are the most fulfilling to you?

____

____

3. What strengths can you bring to the department as a fire officer?

____

____

4. What are some of your fears or concerns?

____

____

5. How might these fears and concerns impact your performance as a fire officer?

____

____

6. What can you do to overcome these fears and concerns, and turn them into strengths instead?

____

____

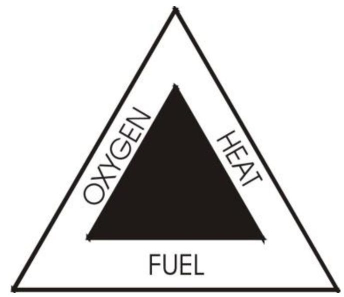
Topic 4: Fire Chemistry

Fire has always been both a friend and foe to humankind. Controlled, it comforts our lives and propels our industries. Uncontrolled, it causes havoc and destroys lives and property. The basic duties of the fireground commander are to control unwanted fire. To accomplish this, a thorough knowledge of fire chemistry is essential.

Fire Defined

Fire can be defined as a rapid oxidation producing heat, light, and products of combustion.

The Fire Triangle



For many years, fire was depicted by the fire triangle. In order for fire to occur, three elements had to be present:

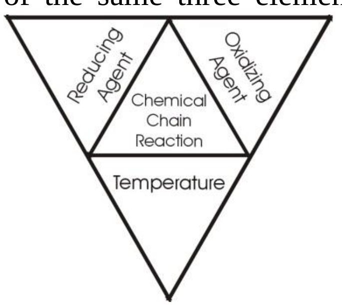
(1) Fuel (fuel vapors within their flammable range)

(2) Oxygen

(3) Heat

The Fire Tetrahedron

An additional theory, the fire tetrahedron, was later introduced to explain the fact that fire is actually further propagated by products produced in the combustion process. The fire tetrahedron is comprised of the same three elements: a reducing agent (fuel), an oxidizing agent (commonly thought of as oxygen, but not limited to oxygen), and temperature (heat). The fourth element of the fire tetrahedron is a chemical chain reaction.



In the chemical chain reaction, fuel vapors combine with heat to produce free radical fuel fragments. These free radical fuel fragments combine with oxygen to form hydroxyl free radicals and heat. The hydroxyl free radicals are now free to burn again. Thus, the chain is propagated and the process repeats itself.

Heat (Temperature)

Heat is a form of energy associated with molecular movement. Heat is measured in degrees. Most people are accustomed to seeing temperature referred to in degrees Fahrenheit. Degree Celsius is another familiar measurement. However, the heat of combustion is most often measured in BTUs. One BTU (British Thermal Unit) is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit at sea level.

Sources of Heat

There are four sources of heat and are listed in Table 4.1.

Table 4.1: The Four Heat Sources

Heat Source	Example
Chemical	Combustion, spontaneous ignition
Electrical	Over current conditions, arcing
Mechanical	Compression, friction
Nuclear	Fission, fusion

Heat is transferred (moved) by three different methods: conduction, radiation, and convection. Conduction occurs when heat is transferred through a medium, usually by direct contact. The heat is transferred from atom to atom. A noninsulated handle of a frying pan that becomes hot during cooking is a common example. Heat has been transferred from the stove, through the pan to the handle. Conduction occurs in a fire situation when heat is transferred along steel structural members. The speed and efficiency of heat transfer depends on the type of material, the intensity of the heat, and the duration of exposure. Conduction is usually the least significant heat transfer method encountered at structure fires.

Radiation is the transfer of heat via electro-magnetic waves. It does not require a medium, and moves in all directions. We see radiation daily as the sun heats the earth. When fire spreads to adjacent exposure buildings it is usually because of radiated heat. Radiated heat can pass through opaque objects or materials including glass and water. The space between the heat source and the receptive materials is not necessarily heated to an equal intensity. Radiated heat is a significant factor in the spread of fire within a structure and/or to exposed structures.

Convection is the transfer of heat via a liquid or gaseous medium. One example of this is a boiler that uses water as the medium to heat the radiator within a building. We commonly see the effects of convection in a fire situation as heat rises, using smoke and gas as the medium. Convection can cause fire to break out several floors above the point of origin. If heated smoke and gases can no longer travel upwards, they will travel horizontally instead, banking downwards when they reach a wall. Convected heat is the most significant cause of fire spread within a structure. Preventing the transfer of heat is one of the primary functions of fire suppression.

Fuel (Reducing Agent)

A fuel is any substance that will produce heat during combustion. Fuels are also known as reducing agents, substances that are capable of reducing an oxidizer and losing electrons in the process.

Fuels can exist in three physical forms: solid, liquid, and gas. Regardless of its original form, the fuel must first be vaporized (turned to gas) before it can be ignited. Solids and liquids do not burn; they give off flammable gases that burn. The fuel for a flammable or combustible liquid is the vapor. Generally, it is easier to ignite a gaseous fuel than a solid fuel because it does not need to be vaporized first.

Fire is classified by the type of fuel involved. These are shown in Table 4.2.

Table 4.2: Classes of Fuels

Class	Type of Fuel	Examples
A	Ordinary Combustibles	Paper, wood, clothing, trash, grass, rubber, many plastics
B	Flammable Liquids and Gases	Gasoline, alcohol, grease, flammable gases
C	Energized Electrical Equipment	Overheated motors, electronic equipment, circuit breakers
D	Combustible Metals	Magnesium, lithium, titanium, sodium, potassium, calcium, zirconium, zinc

One characteristic that all fuels have in common is an ignition temperature. This is the minimum temperature that is required to cause self-sustained combustion, independent of a heat source. Ignition temperatures vary widely between different fuels.

Table 4.3: Approximate Ignition Temperatures of Some Common Fuels

Solids		Liquids *		Gases *	
Example	Ignition Temp (°F)	Example	Ignition Temp (°F)	Example	Ignition Temp (°F)
Matches	325	Acetone	869	Methane	999
Carbon Soot	366	Kerosene	410	Propane	842
Paper	450	Acrolein	455	Butane	550
Wood (average)	392	Gasoline (low octane)	536	Carbon Monoxide	1128
Cotton Fibers	490 - 750	Ethyl Alcohol	685	Hydrogen	932
Polyvinyl Chloride	800 - 900	Isopropyl Alcohol	750	Anhydrous Ammonia	1204
Polyester	840 - 1040	Turpentine	488	Acetylene	581

*Source: NFPA Fire Protection Guide to Hazardous Materials, 11th Edition

These ignition temperatures are approximations based on laboratory testing. Every fire situation is different. The same fuel may ignite at different temperatures in different situations. Factors that influence when a fuel actually ignites include:

- ❑ Moisture content of the fuel
- ❑ Relative humidity in the atmosphere
- ❑ Fuel configuration (horizontal or vertical)

- ❑ Shape of the fuel
- ❑ Intensity and duration of heat exposure
- ❑ Amount of fuel surface exposed
- ❑ Ratio of fuel surface to mass of fuel

Oxygen (Oxidizing Agent)

All matter will oxidize when exposed to air. This is called the *oxidation process.* Normal oxidation is the slow combination of a material with oxygen, resulting in the liberation of both products of combustion and heat energy. Normal oxidation is a slow process because little or no heat is added. The rusting of metal or the yellowing of paper are examples. When heat is added the process is accelerated the result is combustion.

Oxygen is not a flammable gas. Rather, it supports and assists the combustion process. The available concentration of oxygen directly affects the combustion process.

Table 4.4: The Effects of Oxygen Content on Combustion

% Oxygen in Air	Effects on Combustion
21	Intensifies the combustion process. Not often encountered on the fireground.
16 - 21	Open burning with flame production.
10 - 15	Smoldering with minimal flame production. Inefficient combustion. Produces dense, toxic smoke. Caused by lack of ventilation or extreme density of fuel.
0 - 9	Combustion will not occur.

Table 4.5 shows the effects of oxygen depletion on human health just for comparison. It is important when considering the tactic of smothering a fire by excluding oxygen. In fact, OSHA requires that personnel wear SCBA when entering atmospheres containing less than 19.5% oxygen. (Note: This data does not account for individual differences in breathing rate or length of time exposed. The symptoms also reflect reduced oxygen levels only. If the atmosphere is contaminated with toxic gases, other symptoms may develop.)

Table 4.5: The Effects of Oxygen Depletion on Human Health

% Oxygen in Air	Symptoms
21	None. Normal condition.
19.5	*OSHA legal limit requiring SCBA.*
17	Some impairment of muscular coordination. Increase in respiratory rate to compensate for lower oxygen concentration.
12	Dizziness, headache, and fatigue.

9	Unconsciousness.
6	Death within a few minutes from respiratory failure and concurrent heart failure.

This side of the fire tetrahedron is not limited to oxygen. Oxidizers will intensify a fire even more by releasing oxygen or heat or both. Oxidizers are broken down by NFPA into four separate classes *(Table 4.6)*. According to this classification scheme, oxidizers can range in hazard from Class I (slight increase in burning rate) to Class IV (capable of undergoing explosive reactions).

Table 4.6: Oxidizers (Class, Descriptions and Examples)

Class	Description	Examples
1	An oxidizer whose primary hazard is that it slightly increases the burning rate, but does not cause spontaneous ignition when it comes in contact with combustible materials.	• All inorganic nitrates (unless otherwise classified) • Hydrogen peroxide solutions (>8%, and up to 27.5%) • Nitric acid (≤ 40%)
2	An oxidizer that will cause a moderate increase in the burning rate or which may cause spontaneous ignition of combustible materials with which it comes in contact.	• Calcium hypochlorite (≤50% by weight) • Hydrogen peroxide (>27.5% and up to 52%) • Nitric acid (>40%, but <86%)
3	An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact, or which will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.	• Calcium hypochlorite (>50% by weight) • Nitric acid, fuming (>86%) • Sodium chlorate
4	An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. In addition, the oxidizer will enhance the burning rate of combustibles and may cause spontaneous ignition.	• Ammonium Perchlorate • Hydrogen peroxide solutions (>91%) • Tetranitromethane

The Chemical Chain Reaction

The last component of the fire tetrahedron is the chemical chain reaction. It is a self-sustaining series of chemical activity in which the products of the reaction contribute directly to the continuance of the reaction.

The chain reaction in combustion is begun when a reducing agent (fuel) is exposed to an oxidizing agent (air or an oxidizer) in the presence of sufficient heat. The molecular structure of both the fuel and the oxygen (or oxidizer) are altered or changed. Electrons are lost and received. Chemical changes of combustion produce electrons known as free radicals.

Molecular change also produces heat. This is called an exothermic reaction. The heat generated causes more free radicals to be produced. This, in turn, causes more heat again. In theory, once this reaction is begun, it will continue as long as sufficient heat, fuel, and oxygen are available.

The Combustion Process

Simply stated, the process consists of the following steps:

1. The presence of heat increases oxidation.
2. The fuel undergoes chemical and physical changes as it oxidizes.
3. The fuel produces vapors.
4. A molecular change occurs between the vapors and the oxygen within the air.
5. This change produces heat, which will increase the oxidation.
6. Flame production occurs when the fuel's ignition temperature is reached.
7. Heat and light are produced.

This process may be oversimplified, for there are many other variables and factors involved. However, there are two key points that must be remembered. First, combustion is a dynamic chemical process. Second, the four components of the tetrahedron must be present in sufficient quantities and a proper ratio in order to sustain combustion.

Summary

Fire is defined as a rapid oxidation producing heat, light, and products of combustion. For many years, it was depicted using the fire triangle with three necessary elements: fuel, heat, and oxygen. An additional theory, the fire tetrahedron, was later introduced to explain the fact that fire is actually further propagated by products produced in the combustion process. It consists of a reducing agent (fuel), temperature (heat), oxidizing agent (oxygen), and a chemical chain reaction. This chapter provided an overview of each.

Chapter Review Questions

1. What are the three elements of the fire triangle?

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2. What are the four elements of the fire tetrahedron?

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3. List the four sources of heat and give an example of each.

4. List the three methods of heat transfer (movement) and give an example of each.

5. What must happen to a fuel before it can burn?

6. Define ignition temperature.

7. What are some of the factors that influence when a fuel actually ignites?

8. What is the OSHA legal limit requiring the use of supplemental oxygen in an oxygen deficient atmosphere?

9. What is meant by the "chemical chain reaction?" How does it work?

Topic 5: Fire Phases

A fire generally goes through three predictable phases: incipient, free burning and smoldering. However, it is important to note that numerous variables can affect a fire's behavior. A fire may or may not go through each of the phases. The duration of each phase can vary drastically. And, it cannot be guaranteed that all fires will begin or end with a particular phase. These phases are a generalization of what is likely to occur.

It is important for the fire officer to understand these three phases of fire, how to recognize them and the hazards associated with each in order to make appropriate strategic and tactical decisions.

The Incipient Phase

The incipient phase is generally the first stage of a fire. The temperature of the room is raised only slightly: 100°F to 110°F. The oxygen content in air is also close to normal: 20%. Smoke is present above the site of the fire, but only impairs visibility slightly. Minor amounts of gases are being produced. Those gases include water vapor, carbon dioxide, carbon monoxide, and sulfur dioxide. Other gases may be present depending on the fuel involved.

The temperature at the base of the fire is approximately 100°F. However, convected heat begins to form a thermal column. Heat and smoke rise above the fire into upper levels of the room or building. Radiated heat begins to preheat fuels in the immediate fire area.

The fire will continue to grow as more fuel is consumed. The overall atmosphere becomes progressively hostile with increased heat, increased toxicity, and decreased visibility.

The Free Burning Phase

In the free burning phase, the temperature is significantly higher in the fire room, as high as 1300°F in upper areas. The oxygen level drops to between 16% and 20%. Visibility is seriously reduced. The production of gases continues at an increasing rate with gases collecting at upper levels.

Convected heat forms a definite thermal column. Heat and smoke rise vertically above the fire. Once they reach the ceiling or another vertical barrier, heat and smoke start spreading horizontally. Cooler, fresher air is pushed down and out.

Radiated heat will preheat other fuels in the area. Fuels with fairly low ignition temperatures (300°F - 500°F) begin to ignite. Convected heat may begin to affect objects such as beams, pipes, and walls that extend to uninvolved portions of the structure.

The fire behavior depends on the availability of oxygen. Fire will continue to grow as oxygen enters the building through windows, doors, or other openings. It will intensify even further when the fire vents itself to the exterior atmosphere. If, on the other hand, there is insufficient oxygen to sustain combustion, fire will enter the smoldering phase.

The Smoldering Phase

During the smoldering phase, the temperature in the room may drop to approximately 1000°F. These temperatures will be present throughout most of the room, no longer concentrated in the upper areas alone. The oxygen level drops to between 11% and 15%. Heavy smoke will be present, drastically reducing visibility in the area. Significant concentrations of gases will be present due to incomplete combustion. Toxicity of the atmosphere will be extremely high.

Although the thermal column will no longer be distinctly visible, convected heat will be affecting fuels in the entire area. There will be less radiant heat because of reduced flame production. However, the heat present will increase the pressure within the structure.

The critical factor in the smoldering phase of a fire is the reduced oxygen level in the fire area. If this condition continues, combustion will cease, and the heat and pressure will gradually dissipate. While fire fighters do not often encounter a fire in the smoldering phase, it is important to recognize it and understand its dangers. The most serious consequence is the threat of a backdraft. Backdraft is discussed in the next section.

What fire fighters do often encounter are fires that have vented themselves after passing through a smoldering phase. The heat may cause a window to fail, introducing new oxygen into the involved room or building. The build up of pressure inside the structure may also cause an air exchange with the exterior atmosphere through cracks or other openings in the building. Once the fire has vented, combustion will increase significantly. It will generally result in the fire entering (or re-entering) the free burning phase.

Backdraft

A backdraft is defined as a rapid combustion of heated gases and suspended fuel particles when oxygen is introduced into a fire structure that has a low concentration of oxygen resulting from inadequate ventilation. Backdrafts can result in extensive property damage, and pose a genuine threat to fire fighters.

Backdrafts are usually encountered in situations where a fire has been smoldering for a prolonged period in a relatively confined area. The room or building is vented suddenly, either because the pressure buildup causes a window or other opening to fail, or because someone inadvertently opens a door or window, unaware of the consequences. Pressure and heated gases rush from the fire area. As the pressure is equalized, fresh oxygen from the exterior atmosphere enters the room or building. Oxygen levels return to near normal. Suspended fuels and flammable gases that have accumulated within the fire area ignite. The ignition often occurs with a near-explosive force. Fire fighters have been killed or injured by the force of a backdraft.

It is important to recognize the signs of a potential backdraft. They include darkened smoke; stained windows; little or no flame present; dark smoke issuing from cracks or other openings; a closed, tight structure; and smoke exiting the structure in "puffs," rather than "billowing."

The proper method of controlling a potential backdraft situation is to carefully vent the structure, releasing the pressure and gases inside. The preferred method is to vent vertically, as high as possible, with a coordinated suppression effort. Horizontal venting is recommended only when vertical venting is not practical or not safe for some reason, and even then must be done with extreme caution.

Flashover

Flashover is a more common occurrence than backdraft, although less information is actually known about it. Flashover is the stage of a fire at which all fuel surfaces within the fire area are heated to their ignition temperatures and ignite. It was originally thought to be caused by the release of flammable gases during combustion. Now it has believed to be attributed to the overall build up of heat caused by the fire.

The size of the fire area and the amount of available fuel load will impact the development of flashover. Flashover will occur sooner in smaller areas containing a high fuel load, whereas the opposite is true for a large area with little fuel loading. Tests of an ordinary dwelling with plaster finish and a light fuel load indicate that approximately 30 minutes of burning is required prior to flashover. However, that is only one example. It may occur a lot quicker under other conditions.

Flashover significantly increases the area of fire involvement, as well as the rate of combustion. It usually requires a dramatic increase in suppression efforts. Flashover usually occurs during the incipient or free burning phases, and can be the connecting process between the two. It may happen before fire fighters ever arrive on-scene, or a considerable time after firefighting efforts have begun. Fire fighters need to be alert to indications such as sudden smoke build up in a previously uninvolved room, accompanied by fire breaking through a wall or other opening. At the height of the flashover, fire fighters will see smoke and flames rolling across the ceiling. This is a very dangerous situation. The heat at ceiling level during a flashover can range from 750°F to 1000°F. Flame spread can exceed six feet per second.

Summary

Fire generally goes through three predictable phases: incipient, free burning and smoldering. However, all fires are different. They may not go through all three phases. The duration of each phase may vary drastically depending on conditions. Understanding these phases and the characteristics of each will help the fire officer make appropriate decisions regarding tactics and strategies.

Two other conditions that all fire fighters must be alert to are backdraft and flashover. These do not occur at every fire. However, either condition can result in death or injury to fire fighters if they do not take adequate safety precautions.

Chapter Review Questions

1. Complete the table below describing the three different fire phases.

Phase	Room Temperature	Oxygen Content	Characteristics
Incipient			
Free Burning			
Smoldering			

2. What is the most serious consequence of a fire in the smoldering phase?

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3. What is the difference between backdraft and flashover? What causes these conditions?

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4. What are the signs of a potential backdraft?

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5. What is the proper method for controlling a potential backdraft situation?

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6. What are some indications of an impending flashover?

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7. How quickly can flame spread in a flashover situation?

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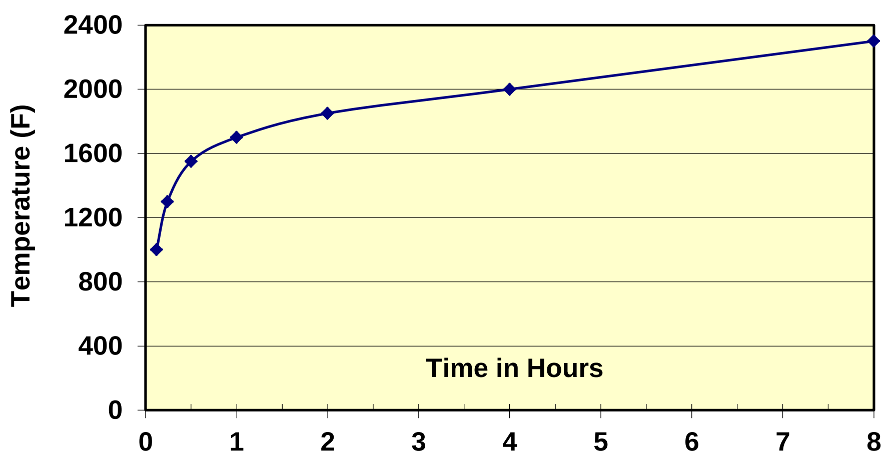
Topic 6: Effects of Time

The length of time takes before a fire is discovered and reported, and the time it takes before fire fighters are on-scene and can begin their extinguishment efforts, are critical factors in the development of a fire. The more time that passes, the more damage done. This is a major reason why we place such a heavy emphasis on early detection and warning systems, fire prevention practices and public fire safety education.

The Standard Time-Temperature Curve

A fire will generate heat rapidly once ignition occurs. Temperatures within the room can reach 1000°F in five minutes, and 1300°F in ten minutes. (Figure 6.1) This brief period of rapid heat rise is generally the most critical in the fire's development. The threat to property dramatically increases. The fire rapidly moves from an incipient stage to the free burning phase. Flashover may occur. The amount of fuel involved will increase rapidly since the ignition temperature of most ordinary combustibles ranges from 400°F to 1400°F. As the fire grows, so does the need for suppression activities and resources. The normal ambient atmosphere becomes poisoned and super-heated.

Figure 6.1



Temperature	Time
1000°F	5 minutes
1300°F	10 minutes
1550°F	30 minutes
1700°F	1 hour
1850°F	2 hours
2000°F	4 hours
2300°F	8 hours

This curve was developed as a standard for use in the testing and rating of a material's fire-resistive qualities. The curve represents the duration of time required for a "typical" Class A structure fire to reach specific temperature levels. The data is based on structure fire tests conducted at the National Bureau of Standards.

Fire Department Reflex Time

Even when response time from a fire station to the fire scene is less than five minutes, fire fighters seldom have the opportunity to control a fire's initial rapid growth. Response time is but a portion of the total reflex time. Reflex time is defined as the total time elapsed from a fire's beginning until extinguishment is completed. It includes a number of factors.

Detection of the Fire

Often the most critical factor in the development of a fire is the time between when it starts and when it is detected. We need only look at a few common fire scenarios to see how significant this time period is. For example, most of our nation's fatal fires occur in residential occupancies, at night when people are asleep. All too often, there is either no smoke detector or the smoke detector does not have a working battery. There is a significant delay before the fire is discovered. Meanwhile, the building occupants have inhaled perhaps fatal levels of smoke and toxic fire gases. The fire builds to a point where it is no longer easily controlled. A properly functioning smoke detector could detect these fires in the early stages, long before they reach fatal levels.

Another reason that automatic detection and notification systems are so important is that they provide protection when a building is occupied. When residents are not home or when a business is closed, there may be no one around to discover a fire in its early stages, long before they reach fatal levels.

Fire Department Notification

How long does it take building occupants to notify the fire department? We teach people to call right away, but it does not always happen. Sometimes there is a delay in finding a phone. Some people panic when they try to report an emergency, which further delays getting accurate information to response personnel.

In some facilities, people have to call an internal number to report an emergency to the site operator who in turn must call the appropriate response agency. Large companies that have their own emergency response teams often choose to investigate the complaint before calling the fire department. Most of the time, these site emergencies are minor situations that can be effectively handled by site personnel.

Take, for example, the fire in the MGM Grand Hotel in Las Vegas on November 21, 1980. Eighty-five people lost their lives in that fire. Over 600 people were injured. There was approximately a six-minute delay between the time that fire was discovered and the time it was reported to the fire department. *Six minutes!* That is not a lot of time. In fact, a hotel employee tried to extinguish the fire during those six minutes; it was not left to grow unattended. However, had that fire been reported immediately, there is a good chance that no one would have died and no one would have been injured.

Receipt of the Alarm

It takes a little time for the alarm to actually be "received." The dispatcher must ask the caller a series of questions in order to make a proper dispatch. What type of emergency is this? If it is a fire, what kind of fire? Structure fires, wildland fires, etc. all require different responses. Are there other hazards or problems on-scene that may require additional resources: burn victims, hazardous materials, down power lines? It may take time to get an accurate address and cross street. If the caller is a young child or there is a language barrier of some kind, it may further delay the process.

Dispatching Units

Once the dispatcher receives the information, he or she will need to determine which units to send. Some areas have computer aided dispatch systems that automatically select the nearest available units and may select units based on the type of resources required. In areas that do not have computer-aided dispatch, the dispatcher must work off a series of "run cards" and manually track which units are available.

Sometimes two dispatchers will work together, one taking the information from the caller and one preparing to dispatch the appropriate units. This usually cuts down the dispatch time slightly. However, when there are not two dispatchers available, or when the second dispatcher is working another emergency, one person ends up doing everything.

Clearing the Stations

How long does it take you to clear the station when the bell goes off? This time varies considerably, depending on the time of day or what is going on when the alarm comes in. Generally, it takes more time at night when fire fighters are asleep than it does during the day. It takes a little extra time if someone is caught in the shower when the bell goes off. If fire fighters are involved in a drill, at either the station or somewhere else, there may be a delay, as they have to put equipment back on the rig. Everyone can think of numerous situations, which may slow the actual response time.

Some communities depend on volunteers for fire protection. In these situations, there may be an even longer delay before fire fighters can respond to the station and pick up the engine.

Response Time

Many factors affect response time. The first, of course, is just distance from the station to the fire scene. Others include traffic conditions, delays due to road construction, the route of travel chosen, etc. One very important factor sometimes is the information received from the caller. Take, for example, a vehicle fire or accident reported on the freeway. The direction of travel is almost as important as the specific location. It is common for there to be delays when a second unit has to be dispatched, or the first unit must go clear to the next exit and circle around.

Arrival and Size-Up Time

A good fire officer recognizes that it takes a little bit of time to properly position apparatus and to size-up the fire. This investment of time is essential to protecting the lives of fire fighters and can make a tremendous difference in the tactics and strategy employed on the fireground.

Conducting Fireground Evolutions

Every fire fighter knows that it takes time to don an SCBA, pull a hose line, throw a ladder, prime the pump, and charge the line, etc. That is why training is so important; practicing these fireground evolutions until personnel are proficient. Yet, no matter how proficient fire fighters are, it is still going to take precious time. If something goes wrong along the way (equipment malfunctions, someone makes a mistake, or someone gets hurt) it merely adds another delay.

Control and Extinguishment

Even after control and extinguishment efforts have begun, the fire may still be growing in some areas. "Reflex time" incorporates the total time it takes to bring the fire under control.

Summary

Time is a critical factor in the development of a fire. It does not take long for fire to generate a lot of heat, smoke, and toxic fire gases. When reflex time is compared to the time-temperature curve, it is easy to see that any delay can have a significant impact on our ability to save lives and property. Effective control only occurs if the fire is in its incipient stages. Adequate size-up and resource management must be accomplished early to keep the fire from escalating out of control.

Chapter Review Questions

1. What are some of the requirements/programs that are put in place in the community to cut down on delays in fire detection and fire department notification?

2. How long can it take room temperatures to reach 1000°F in a fire situation? 1300°F?

3. What is the temperature range where most ordinary combustibles ignite?

4. What are some of the factors involved in fire department reflex time?

5. Where do most of our nations fatal fires occur?

Activity 6-1

TITLE:	Reflex Time
DIRECTIONS:	1. Based on your experience, indicate below what you think are the minimum, maximum, and average times for each of the factors listed. 2. Be prepared to discuss your answers with the class.

	Factor	Minimum	Maximum	Average
1.	Detection of fire			
2.	Fire department notification			
3.	Receipt of alarm			
4.	Dispatching units			
5.	Clearing the stations			
6.	Response time			
7.	Arrival and size-up			
	Subtotal			
8.	Conducting fireground evolutions			
9.	Control and extinguishment			
	Total			

Topic 7: Fire Behavior within Structures

Structure fires represent the vast majority of fires that most departments respond to. This is where most of the civilian deaths and injuries take place. Structure fires present a significant hazard to fire fighters as well. It is essential, both for safety and for limiting fire damage, that the fire officer understands the basics of fire behavior within structures and the factors that can influence this behavior.

Fire Behavior

There are numerous variables which affect how a fire behaves. Some of these are covered in other chapters. However, the following information is generally applicable to most structure fires.

Complete and Incomplete Combustion

The combustion process may either be complete or incomplete. The process of complete combustion results in the formation of carbon dioxide, water vapor, and heat energy. The greatest concern with complete combustion is the ongoing chemical chain reaction. If there is sufficient heat present it will break down the compounds of carbon dioxide (CO_2) and water (H_20) into individual molecules of carbon and oxygen, plus a free radical called the hydroxyl group (HO). These are now free to recombine with other molecules and free radicals to again form carbon dioxide, water vapor, and heat energy. It is a self-perpetuating process that will only stop when one of the three sides of the fire triangle is removed, or an extinguishing agent is applied to interrupt the chemical chain reaction. This is referred to as "secondary pyrolysis."

Insufficient oxygen or heat distribution can cause the fuels to burn with diminished effectiveness. This is known as incomplete combustion. The lack of oxygen most often results in the formation of products such as hydrogen cyanide, sulfur dioxide, carbon monoxide, and smoke. Smoke does not have a specific chemical composition, but consists of various amounts of toxic gases, carbon particles, and unburned fuel vapors. Each fuel generates a different kind of smoke with different effects.

Many of the fire officer's tactical problems are associated with smoke. Smoke causes a reduction in visibility and places flammable gases into the atmosphere. It also kills the vast majority of our nation's fire victims. The presence of smoke and toxic fire gases make it necessary for fire fighters to wear self-contained breathing apparatus. The fire officer should make it a priority to assess ventilation needs when faced with smoke in a structure.

Convection

Convection is the most significant cause of heat transfer within a structure. Smoke and heated gases will rise naturally because they are lighter than air. When they can no longer move upward because of a ceiling or other obstruction, they will start traveling horizontally. If they reach another barrier that prevents them from traveling laterally, the smoke and heated gases will begin banking downward. This downward movement is called "mushrooming."

Convection can cause fire to break out in areas distant from the site of origin. The hot air and smoke, under proper conditions, can cause flashover and extend the fire to other rooms not originally involved.

This is especially a problem in long hallways (center hallway construction) or center core construction (high rise) with its poke through construction and curtain wall exteriors. Heat can travel through unprotected vertical openings as it often does in low-rise and high-rise building fires. Heat and/or fire can travel up dozens of floors and cause additional fires in unexpected locations. This is why it is so important for the company officer to check for extension, and to identify the need for vertical or positive pressure ventilation as soon as possible during the size-up process.

Structural members are *usually* not impacted by convection until later during the progress of the fire. However, this is not the case with prefabricated roof assemblies (trusses) that are exposed to heat. These types of roof and ceiling structures fail at a faster rate than conventional roofs because of the metal nail plates used to hold the structural pieces together.

Fire Progress within a Structure

Generally, there are three major factors that will assist, impede, or alter a fire's progress. They are the fuel, air movement and construction features.

Fuel

Fuel plays a significant role in fire spread in many ways. First is the fuel type (Class A, B, C or D). Each behaves differently when burning, and each requires different extinguishing methods. Class A fuels, for example, leave a residue, whereas Class B fuels do not. A Class C fire can be quickly extinguished by shutting off the source of electricity. A Class D fuel will generally react violently with water. Of course, many fires contain several different types of fuels, which make it more difficult to predict fire behavior.

The burning characteristics of different fuels will vary. These burning characteristics include the heat of combustion (the amount of heat that the burning material contributes to the fire), the smoke index (the amount of smoke that the burning material releases), the flame spread (the speed with which the combustible material will become involved once fire occurs), and any negative reactions that the material may have to the fire itself or to the extinguishing agents used.

Fuel division refers to exposed surface area. Saw dust, for example, will ignite and burn more readily than solid wood because more surface area is exposed.

How the fuel is arranged in the structure also makes a difference. The closer that fuels are to one another, the more likely they are to transfer heat. On the other hand, fuels that are densely packed will be slow to ignite because there is less surface area exposed to heat and oxygen. Fuels stacked vertically will burn faster than like fuels laid horizontally.

Fuel load (or fire load) refers to the amount of fuel within the structure. It is a measure of the maximum heat that would be released if all the combustibles in a given fire area burned. In a typical building, the fuel load includes combustible contents, interior finish, floor finish, and structural elements. Fuel load is commonly expressed in terms of pounds per square feet for the average fire load in the building or area. As the fuel loading increases, so does the potential for a larger fire.

Air Movement

As already discussed in the chapter on Fire Chemistry, the availability of oxygen plays a significant role in the combustion process. This becomes more of a problem when heating, ventilation, and air conditioning (HVAC) systems alter the normal convection currents within the structure.

Construction Features

Construction features may impact fire behavior in a number of ways. Because construction features can add to the fuel load, there are strict requirements about what type of construction is used for different occupancies. These requirements include the materials used in construction, exposed structural members, and interior finishings. Other construction requirements designed to restrict the spread of fire and smoke include limiting building size or dividing the building with compartmentalization. The additional use of automatic sprinkler and other fixed extinguishing systems significantly reduce the risk of fire loss.

The Path of Least Resistance

A fire will pretty much follow the path of least resistance. Fire will travel towards adequate, suitable fuel. It will move with the prevailing airflow and away from construction barriers. It will also move away from areas where hose streams are applied. Unless the structure is already fully involved upon arrival, a knowledgeable, experienced fire officer should be able to predict how the fire will behave and progress.

Summary

It is essential, both for safety and for limiting fire damage, that the fire officer understands the basics of fire behavior within structures. Unless the structure is totally involved upon arrival, the fire officer should be able to anticipate fire behavior based on some fairly predictable factors. He or she must understand the impact of complete and incomplete combustion, the process of convection; and how fuel, air movement, and construction features contribute to a fire's growth.

Chapter Review Questions

1. What is the significance of complete combustion? Incomplete combustion?

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2. How does convection contribute to a fire's growth?

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3. What does "mushrooming" mean?

4. What are some of the ways in which the fuel impacts a fire's growth?

5. List some examples of how construction features will affect fire behavior.

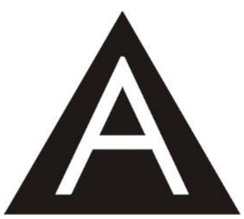
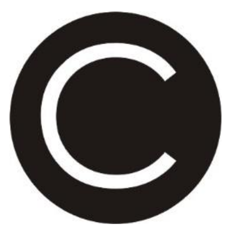
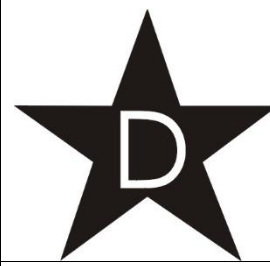
Topic 8: Extinguishing Agents

Although water is the most commonly used extinguishing agent in the fire service, there are many other options. The fire officer must understand the different agents available, what types of fires they may be used on, and the circumstances under which they can be hazardous.

The Four Classes of Fire

Once again, there are four classes of fire: A, B, C and D. It is important to be familiar with the different classes of fire in order to choose the appropriate extinguishing agent. Figure 8.1 below shows the four classes of fire and the symbols that are associated with each.

Figure 8.1: The Four Classes of Fire

Class	Class A Ordinary Combustibles	Class B Flammable Liquids	Class C Energized Electrical Equipment	Class D Combustible Metals
Letter Symbol				
Picture Symbol				

Water

The extinguishing agent used most commonly in the fire service is water. Because water has the ability to absorb large quantities of heat, it serves primarily to cool the fire. The more surface area that is exposed to the heat the greater the cooling effect. This is why a fog stream is often more effective than a straight stream, and causes less water damage as well.

Another characteristic of water that makes it such an effective extinguishing agent is its high expansion ratio when converted to steam. The amount of expansion varies with the temperature in the fire area.

(Table 8.1) When water expands into steam, it is able to absorb even more heat because more surface area is exposed. Because the steam occupies so much more space than its original volume as water, the steam is able to displace hot gases, smoke, and other products of combustion. It may even help to smother a fire in a relatively confined space by excluding oxygen.

Table 8.1: Expansion Ratios of a Cubic Foot of Water

Original Volume	Temperature	Expansion Ratio
1 Cubic Foot	212°F (100°C)	1,700:1
1 Cubic Foot	500°F (260°C)	2,400:1
1 Cubic Foot	1,200°F (649°C)	4,200:1

Types of Fires Water Can Be Used On

Water is most effective on Class A fires, and again functions by cooling the burning material below its ignition temperature.

The use of water on Class B fires may or may not be appropriate, depending on the circumstances. If the fire is small, it is far better to use another extinguishing method or agent. For example, water applied to a fire in a frying pan containing grease or oil will cause the fuel to splatter, thereby spreading the fire. Smothering the fire by putting a lid on the frying pan or using a dry chemical fire extinguisher to interrupt the chemical chain reaction would be far more effective. However, fire fighters are more often faced with much larger Class B fires. Sometimes the quantity of fuel makes it necessary to use water; no other extinguishing agent is available in sufficient quantities to put out the fire.

It is important to know the type of flammable liquid that is burning in order to determine how to best utilize the available water. Gasoline, for example, is a nonpolar flammable liquid, meaning that it will not mix with water. It has a specific gravity less than 1, which means that it will float on water. The use of water alone will not be effective. However, water used in conjunction with foam will work. The foam is designed to "modify" the density of water, causing it to float on top of the surface of flammable liquids. It creates a film that seals the surface of the flammable liquid, thereby preventing further vapor production. Since it is the vapors that burn, not the liquids themselves, the prevention of vapor production will serve to extinguish the fire.

When the flammable liquid has a specific gravity greater than one, water can be used effectively to smother the fire. Water floats on the surface of these liquids and requires no "modification" to seal off the surface of the liquid and prevent vapor production.

If water is used on a polar flammable liquid, such as alcohol, it will mix with the fuel. The addition of water to the liquid will decrease the overall vapor content of the resulting mixture, ultimately extinguishing the fire by eliminating flammable vapor production. The disadvantage of this method is that it may require large amounts of water. This raises the possibility of overflow from containers or containment facilities, and requires extra measures to contain runoff. The use of foam can help to reduce the amount of water required.

Water is hazardous on Class C fires because it conducts electricity. However, once the equipment or circuit is de-energized, the fire can be treated as a regular Class A or Class B fire depending on the fuel involved.

Water is also generally not recommended on Class D fires because many of the burning metals are water reactive, producing both toxic gases and excessive heat. Special extinguishing agents are required.

Water Additives

There are a number of different additives available that can be used to make water more effective. Wetting agents can be used to reduce surface tension, allowing the water to penetrate burning combustibles more effectively and closely packed, baled, or stacked materials. Water thickeners may be added to increase viscosity so that the water blankets a fire better, and does not run off surfaces as quickly. Friction loss can be reduced with the addition of flow agents making it possible to deliver higher pressure to the nozzle.

Water Reactive Chemicals

A number of chemicals are water reactive. In some cases, the reactions with water can be extremely violent and explosive. Table 8.2 provides a brief overview of some of the functional groups that are water reactive.

Table 8.2: Examples of Water Reactive Chemicals

Functional Group	Examples
Alkalies (Caustics)	Caustic soda (sodium hydroxide or lye), caustic potash (potassium hydroxide)
Carbides	Calcium carbide, lithium carbide, potassium carbide, barium carbide
Hydrides	Sodium hydride, lithium hydride, lithium aluminum hydride
Oxides	Sodium oxide, calcium oxide (quicklime or unslaked lime)
Alkali Metals	Lithium, sodium, potassium
Alkaline Earths	Magnesium, beryllium, calcium

Foam

The most common use of foam is on flammable and combustible liquid fires. It impacts all three sides of the fire triangle. Its light density, high water content, blanketing tendencies, and resistance to rapid breakdown allows foam to both smother the fire and act as a flame barrier. Foam suppresses the release of vapors from flammable and combustible liquids, reducing the available fuel. It also has minimal cooling properties. Foam does not, however, work to inhibit the chemical chain reaction.

Many fire departments are now using foams on Class A fires, including structure and wildland fires, because solutions with low surface tensions easily penetrate the combustible fuels. They reduce the amount of water needed to extinguish the fire and minimize the possibility of reignition.

The Limitations and Disadvantages of Foam

There are times when foam is not effective or not safe. Because of its high water content, foam cannot safely be used on water-reactive chemicals or energized electrical fires. It must be compatible with the burning fuel. It is less effective on fuels with high vapor pressures.

Foam is designed to be used on horizontal surface fires. It cannot blanket fuels that are flowing vertically, such as burning fuel leaking from an elevated tank or pipeline. However, some foams are capable of "following" a flowing fuel fire.

The greatest hazard generally associated with foam is a disturbance of the foam blanket. If the blanket is disturbed, such as by a strong hose stream or personnel walking through the foamed area, the fire is easily reignited. Uneven topography can also affect the density of the foam blanket. It is important to maintain an intact foam barrier at all times and to keep personnel out of the area.

There is no such thing as a perfect "all purpose" foam. Different types are designed to be used on different types of fuels. It is also important not to mix the various types foams since many are not compatible and may cause the foams to become ineffective at extinguishing the fire.

Protein Foam

Protein foam is composed of chemically broken-down natural protein solids. It is commonly used in concentrations of 3% or 6%. It has excellent elasticity, water retention capabilities, and high strength. It generally has high stability, high heat resistance, and good resistance to burnback. Protein foam is nontoxic and biodegradable after dilution. It works well within a temperature range of 20°F to 120°F. However, protein foam is not well suited for use on polar solvents, in extremely cold temperatures or for subsurface injection.

Fluoroprotein Foam

These are protein foams fortified with fluorinated solvents. They are commonly used in concentrations of 3% or 6%. Their "fuel shedding" property allows the foam to separate from the flammable liquids, making them more effective under conditions where the foam becomes coated with fuel (i.e., subsurface injection of foam for tank fire fighting, or deep petroleum or hydrocarbon fuel fires). They have superior vapor securing and burnback resistance characteristics. Fluoroprotein foams are nontoxic and biodegradable after dilution. They work well within a temperature range of 20°F to 120°F.

High Expansion Foam

High expansion foam is composed of synthetic hydrocarbon surfactants that foam copiously with a small input of turbulent action. It is generally used in about 2% proportion in water solution. When generated in sufficient volume, it can prevent air from reaching the fire. Heat from the fire converts the water in the foam to steam, which both absorbs heat from the burning fuel and serves to displace oxygen. Because of its relatively low surface tension, the foam solution not converted to steam will tend to penetrate Class A materials. When accumulated in depth, high expansion foam can provide an insulating barrier for protection of exposed materials or structures not involved in fire, thereby preventing fire spread.

When high expansion foam is generated from gases of combustion, it becomes toxic. SCBA is required for entry into a foam filled passage.

Synthetic (AFFF) Foam

Aqueous film-forming foam (AFFF) agents are composed of synthetically produced materials. They are dual action foams. The first action forms a blanket of strong foam that spreads over the surface of the burning liquid to smother the fire and retard vapor production to below flammable limits. The second action is the forming of a film or aqueous solution between the foam and the surface of the liquid. This film also serves to smother the fire and prevent vaporization. However, it has the added benefit of being self-healing; it will reseal open areas caused by agitation of the flammable liquid surface. This characteristic makes AFFF one of the most dependable and versatile foams available. Often AFFF agents are used on flammable liquid spills to prevent ignition. They can also be used on fires containing both Class A and Class B type fuels where deep penetration is needed.

AFFF foams are compatible with dry chemical. They do not need special application devices, and as such are very versatile. They are nontoxic and biodegradable. They work well within a temperature range of 35°F and 120°F. And, they are available for proportioning to a final concentration of 1%, 3%, and 6% by volume.

"Alcohol-Type" Concentrates (ATC)

Alcohol-type concentrates were developed for use on water-soluble or water miscible fuels, polar solvents and hydrocarbons. These fuels can rapidly break down ordinary fire fighting foams. The alcohol-resistant concentrates are proprietary compositions of several types. Some contain a protein or fluoroprotein base. The most common contain a base of aqueous film-forming foam concentrate. They exhibit AFFF characteristics on hydrocarbons and produce a floating gel-like mass for foam buildup on water miscible fuels. Normal temperature ranges for any of the alcohol-type agents are 35°F to 120°F.

Class A

Class A foam is a fairly new development in the foam line of extinguishing agents. It is designed for both Class A and B fires. However, its use has been primarily in the Class A or wildland environments.

Class A foam's characteristics differ from other foams in a number of ways. It is applied as water or compressed air driven. It is formed as air bubbles surrounded by water, just as other foams are, but the similarity ends there. Where other foams are formulated to maintain their bubble structure as long as possible, this foam is designed to drain the water from its bubble structure in order to wet the fuels.

Characteristics of Class A Foam

- ❑ A surfactant in the foam to allow spread and penetration by reducing surface tension.

- Increased ability to absorb heat with a high surface area to mass ratio of water.
- The wet white color reflects radiated heat to keep fuels cooler.
- This foam holds water on vertical surfaces, allowing water to penetrate fuels.
- It removes oily substances from fuels to allow water penetration.
- Its high visibility (white color) helps fire fighters identify areas already covered.
- Five gallons will treat between 500 and 2,500 gallons of water, making Class A foam relatively inexpensive.

Because of these and other characteristics, Class A foam is finding its way into more and more wildland applications. Many large departments are making Class A foam a standard component on their wildland units.

Carbon Dioxide (CO_2)

Carbon dioxide has been used for many years to extinguish fires involving flammable liquids, gases, and energized electrical equipment. It functions primarily by smothering the fire since it is an inert gas that does not support combustion. Because it discharges at a temperature of –110°F, it also has a cooling effect. However, its cooling properties are minimal. Carbon dioxide is stored as a liquefied gas, but is applied in a gaseous state. It leaves no residue, thus reduces the need for clean up. Carbon dioxide used in both portable fire extinguishers and in fixed extinguishing systems.

Limitations and Hazards

Carbon dioxide has limited application for fires involving ordinary combustibles because of its inability to penetrate deep-seated fires. It is not an effective extinguishing agent on fuels that contain their own oxygen supply (such as cellulose nitrate). Carbon dioxide cannot be used to extinguish fires involving reactive metals (such as sodium, potassium, magnesium, titanium and zirconium) or fires involving the metal hydrides. The metals and hydrides decompose carbon dioxide, often causing a violent reaction.

Carbon dioxide is mildly toxic. However, the fact that it will displace oxygen is of much greater concern. Large quantities used in relatively confined spaces can quickly cause oxygen-deficient atmospheres. A concentration of 9% is about all that most persons can stand without losing consciousness in a period of a few minutes. Breathing a higher concentration can render a person helpless almost immediately. Because carbon dioxide is 1.5% times heavier than air, the highest concentrations will be located near the floor.

The other hazard associated with carbon dioxide is that it comes out very cold as it is discharged from a portable fire extinguisher. Contact with the skin can cause a frostbite injury. Persons using a carbon dioxide fire extinguisher should avoid direct contact with the nozzle horn.

Halogenated Agents

Halogenated extinguishing agents (halons) are hydrocarbons in which one or more hydrogen atoms have been replaced by atoms from the halogen series: fluorine, chlorine, bromine, or iodine. This substitution is what gives the halogenated agents their extinguishing properties. Halon is used in both portable fire extinguishers and in fixed extinguishing systems.

Although there are several types of halogenated extinguishing agents, only two are in common use today: Halon 1211 (Bromochlorodifluoromethane) is used for portable fire extinguishers, while Halon 1301 (Bromotrifluoromethane) is used in fixed extinguishing systems. Because they are either gases or liquids that rapidly vaporize in fire, halons leave no corrosive or abrasive residue after use. These properties make halons the preferred choice for use around electrical and electronic equipment.

The extinguishing mechanism of the halogenated agents is not clearly understood. However, they are generally thought to work by interrupting the chemical chain reaction. They may be used safely on Class C fires because they do not conduct electricity. Halon is very effective at quickly extinguishing fires in flammable liquids and vapors. It is approximately 2.5 times more effective than an equal weight of carbon dioxide.

The effectiveness of Halon on Class A fires is less predictable. It depends largely on the specific type of fuel and its configuration. Most plastics behave as flammable liquids; they can be extinguished rapidly and completely with relatively low concentrations of Halon. However, Halon has a limited capacity to penetrate a deep-seated fire in ordinary combustibles. In fact, some of the smaller Halon fire extinguishers are not even rated for Class A fires.

Hazards

The toxicity of Halon 1301 and Halon 1211 has been studied extensively. Table 8.4 shows the effects on humans at various concentrations, and the permitted exposure times listed in the NFPA Fire Protection Handbook (17th Edition). These effects can also be attributed partly to the fact that Halon displaces available oxygen, just as carbon dioxide does. All the effects listed disappeared quickly, however, after the exposures were stopped.

Table 8.4: Effects and Permitted Exposure Limits of Halon 1301 and 1211

Halon	Concentration (Percent by Volume)	Effects on Humans	Permitted Time of Exposure
1301	Up to 7	Little noticeable effect	15 minutes
	7-10	Dizziness and tingling of extremities, indicating mild anesthesia	1 minute
	10-15	Dizziness becomes pronounced, physical and mental dexterity is reduced, subjects feel like they may lose consciousness	30 seconds
	Above 15		Prevent exposure

Halon	Concentration (Percent by Volume)	Effects on Humans	Permitted Time of Exposure
1211	Up to 4	Little noticeable effect (2-3%) Dizziness and tingling of extremities, indicating mild anesthesia (3-4%)	5 minutes
	4-5	Dizziness becomes pronounced, physical and mental dexterity is reduced, subjects feel like they may lose consciousness	1 minute
	Above 5		Prevent exposure

The health effects of Halon under normal circumstances are minimal. However, under fire conditions, Halon can be broken down into toxic by-products. Decomposition of halogenated agents takes place on exposure to flame, or to surface temperatures above approximately 900°F. Table 8.5 shows the main decomposition products of Halon in the presence of available hydrogen (either from water vapor or the combustion process itself).

Table 8.5: Main Decomposition Products of Halon

Halon 1301		Halon 1211	
Hydrogen fluoride	HF	Hydrogen fluoride	HF
Hydrogen bromide	HBr	Hydrogen bromide	HBr
Bromide	Br_2	Bromide	Br_2
		Hydrogen chloride	HCl
		Chlorine	Cl_2

Fortunately, these decomposition products have good warning properties; they have characteristically sharp, acrid odors even in minute concentrations. They create a noxious, irritating atmosphere for anyone who must enter the hazard area following a fire. Although brief exposures generally will not produce any lasting health effects, it is recommended that personnel wear self-contained breathing apparatus for protection.

One other problem that has surfaced in recent years is the destructive effects that Halon and other fluorocarbons have on the ozone layer around the earth. Numerous experiments are being conducted in many countries to find an adequate replacement, but there is no immediate solution on the horizon.

Dry Chemicals

Dry chemical is a powder mixture containing sodium bicarbonate, potassium bicarbonate, potassium chloride, urea-potassium bicarbonate, or monoammonium phosphate. Various additives are mixed with these base materials to improve their storage, flow, and water repellent characteristics. Dry chemical may be applied by means of portable fire extinguishers, hand hoseline systems, or fixed systems.

Regular dry chemical is effective on flammable liquid (Class B) and electrical (Class C) fires. However, on deep-seated ordinary combustible (Class A) fires, it may be necessary to supplement its use with a water spray to get beneath the surface of the fuel. Multipurpose dry chemical (monoammonium phosphate), on the other hand, is specifically designed to be more effective on Class A fires, and seldom needs the help of water to completely extinguish the fire. Multipurpose (ABC) dry chemical extinguishers are the most common.

Dry chemical functions primarily by inhibiting the chemical chain reaction. However, it also helps to smother the fire, though to a much lesser extent. Multipurpose dry chemical, in particular, leaves a sticky residue (metaphosphoric acid) on the burning material that seals the glowing material from oxygen, thus extinguishing the fire and preventing reignition.

Limitations and Hazards

The ingredients used in dry chemical extinguishing agents are nontoxic. However, they can be irritating to the respiratory system. Persons not wearing self-contained breathing apparatus should leave the room once the fire has been extinguished, and not re-enter until the powder has had a chance to settle.

Dry chemical powders should not be mixed together indiscriminately. Some of the dry chemicals are compatible, but others most definitely are not. For example, mixing multipurpose (monoammonium base) dry chemical, which is acidic, with an alkaline dry chemical (most of the others) will result in an undesirable reaction that releases carbon dioxide gas together with the formation of caking. Extinguisher shells have been known to explode because of this phenomenon.

Because dry chemical is electrically nonconductive, it can be used safely on fires involving live electrical equipment. However, it is not recommended around delicate electrical equipment such as computers or telephone switchboards because the insulating properties of dry chemical may render such equipment inoperative. It may require excessive cleaning. Because some dry chemicals are slightly corrosive, they should be removed from all undamaged surfaces as soon as possible after fire extinguishment.

Dry chemical also does not produce a lasting inert atmosphere above the surface of a flammable liquid. Consequently, a fire can reignite if sufficient heat or persistent electrical arcing is present.

Metal Extinguishers

There are many types metal extinguishers, each of which has limited use. Although the most common form is a dry powder, liquid extinguishing agents are also available. These extinguishing agents work primarily by smothering the fire. The two most common extinguishing agents, Met-L-X and G-I Powder, are discussed below.

Met-L-X

The brand of metal extinguisher used most commonly by the fire service is Met-L-X. It is suitable for most Class D fires. It is composed of a sodium chloride base with additives. The additives include tricalcium phosphate to improve flow characteristics and metal stearates for water repellency. A thermoplastic material is added to bind the sodium chloride particles into a solid mass under fire conditions. It is stored in sealed containers or extinguishers. No known health hazards result from the use of Met-L-X. It is nonabrasive and nonconductive.

G-I Powder

Another fairly common metal extinguisher is G-I Powder. It is composed of screened graphitized foundry coke to which an organic phosphate has been added. The graphite acts as a heat conductor, absorbing heat from the fire to lower the temperature of the metal to below its ignition point. It also serves to smother the fire. The organic material in the agent breaks down with heat to yield a slightly smoky gas that penetrates the spaces between the graphite particles, excluding air. The powder is nontoxic and noncombustible.

Comparison of Met-L-X and G-I Powders

Although there are numerous types of metal extinguishing agents, Met-L-X and G-I Powder are the most popular and the most versatile. Table 8.6 provides a comparison of how the two agents perform on fires involving common combustible metals. (Source: NFPA Fire Protection Handbook, Fifteenth Edition.)

Table 8.6: Comparison of Met-L-X and G-I Powders

		Met-L-X			G-I Powder		
Metal	**Type Fire**	**E**	**C**	**U**	**E**	**C**	**U**
Magnesium	Dry or oily chips or turnings	🗐			🗐		
	Castings and wrought forms	🗐			🗐		
Titanium	Dry or oily turnings	🗐			🗐		
Uranium	Turnings and solids	🗐			🗐		
Zirconium	Chips and turnings coated with water soluble oil	🗐			🗐		
	Moist chips and turnings	🗐	🗐			🗐	
Sodium	Spills or in depth	🗐			🗐		
	Sprayed or spilled on vertical surfaces	🗐					🗐
Potassium or sodium-potassium alloy	Spill	🗐			🗐		
	Fire in depth			🗐			🗐
Lithium	Spill	🗐			🗐		
	Fire in depth			🗐	🗐		
Aluminum	Powder	🗐			🗐		

E = Capable of Complete Extinguishment, C = Capable of Control Only, U = Unsatisfactory

Selecting the Proper Extinguishing Agent

Selecting the proper extinguishing agent depends on a number of different factors. Obviously, the type and amount of fuel is a major concern. However, the rate and intensity of combustion also impacts the effectiveness of the various extinguishing agents. A very hot fire will cause some extinguishing agents to break down much faster. Of course, another key factor is availability. You cannot use what you do not have.

Table 8.7 provides an overview of the various extinguishing agents and the types of fires they work best on.

Table 8.7: Extinguishing Agent Overview

Agent	Form	Primary Extinguishing Property [1]	Most Effective Application	Limited or Additional Applications
Water	Liquid	Cooling	Class A Fires	Class B Fires
Foam	Liquid	Smothering	Class B Fires	Class A Fires
Carbon Dioxide	Gas	Smothering	Class B and C Fires	Class A Fires
Halon	Gas/Liquid	Inhibits chemical chain reaction	Class B and C Fires	Class A Fires
Dry Chemicals	Powder	Inhibits chemical chain reaction	Class B and C Fires	Class A
Dry Powders	Powder	Smothering	Class D Fires	

1 - Several agents have additional, though minor extinguishing properties.

Summary

There are varieties of extinguishing agents that may be used, depending on the type of fire. Water is the most common extinguishing agent used in the fire service. It works primarily by cooling the fire. There are a number of different additives that can be used to make the water more effective. Foam can be used to "modify" water so that it can be used effectively on flammable and combustible liquids. Foam may also be used on Class A fires to penetrate the combustible fuels more easily.

Other extinguishing agents include carbon dioxide, Halon, dry chemical, and dry powder. These are used most commonly in portable fire extinguishers and fixed extinguishing systems.

Each of these extinguishing agents has advantages and disadvantages. Fire officers must be familiar with the types of fires they may be used on, the fires they should *not* be used on, and the hazards associated with each.

Chapter Review Questions

1. Complete the following tables.

Agent	Primary Extinguishing Property	Fires Most Effective On
Water		
Foam		
Carbon Dioxide		
Halon		
Dry Chemicals		
Dry Powders		

Agent	Associated Hazards
Water	
Foam	
Carbon Dioxide	
Halon	
Dry Chemicals	
Dry Powders	

2. How does water behave on the following flammable liquid fires? What, if anything, must be added to make the water work more effectively?

   Nonpolar (immiscible) floaters: ______________________

   Nonpolar (immiscible) sinkers: ______________________

   Polar (miscible) liquids: ______________________

3. What types of additives may be added to water? What are they used for?

   ____

   ____

4. What are some of the limitations/disadvantages of foam?

   ____

   ____

5. What is the greatest hazard generally associated with foam?

   ____

   ____

6. What types of metals are dry powder extinguishers used on?

   ____

   ____

Topic 9: Water Application

Water has always been the primary extinguishing agent used by the fire service. Yet, when applied inappropriately, water can cause far more damage. It can even compromise the safety of fire fighters.

Methods of Fire Attack

There are three methods of fire attack: direct, indirect and combination. Understanding how and when to apply these methods are very important to the fire officer.

Direct Method

The direct method involves applying a fire stream directly onto the burning fuel. It is most appropriate for small incipient fires, confined fires prior to flashover, and totally involved structures that demand an exterior attack. The direct method employs a straight stream or very narrow fog pattern (30 degrees or less). Extinguishment is obtained when the fuel is cooled to a point below its ignition temperature.

Indirect Method

The indirect method of attack involves applying a fog pattern to the area above the fire rather than directly onto the burning fuel. This method should be used when the fire is confined and high heat levels are present within the area of involvement. Extinguishment is accomplished by directing a fog pattern (30 - 60°) at the ceiling, and playing it back and forth in the superheated gases at ceiling level. The heat converts the water droplets to steam, which both cools the atmosphere in the room and displaces smoke and heated gases. Once initial knock down has been achieved, fire fighters should make entry to extinguish any hot spots.

Great care should be exercised to ensure that fellow fire fighters and/or victims are not in the area when the indirect attack is used. The resulting atmospheric change can make egress difficult, and perhaps even cause injury.

Combination Method

As the name implies, the combination attack uses both the direct and indirect methods simultaneously. It is used to extinguish a free burning fire involving an entire room or structure. Water is applied to both the burning fuel and to the area above the fire in order to cool the fuel *and* the atmosphere in the room. This can be accomplished with a single hose line by first directing a 30° - 60° fog pattern at the ceiling, then rotating it in a clockwise direction throughout the room. (Although the phenomenon is not fully understood, when the nozzle is rotated clockwise it does a more effective job of pushing heat, smoke, and gases away from the fire fighter on the nozzle.)

Maintaining the Thermal Balance

One of the major factors in determining which method to use is *thermal balance,* the temperature differential in the fire area caused by the movement of heated gases.

The source of heat production is fairly localized in the incipient stage of a fire. Temperatures near the floor are still fairly close to normal. However, temperatures start to become stratified as convected heat from the burning fuel rises upward and outward. The heated air spreads out to the corners of the room, cools off, and begins to sink back to the floor. The temperature in the room is stabilized and in thermal balance. The heat differentials that cause this circulation under normal conditions are very slight, generally less than 5-7 degrees.

As the fire continues to build, it generates more heat, which increases the temperature differentials or stratification in the room. The greater the heat differential becomes the more rapidly the circulation will occur. If the circulation becomes too rapid, the atmosphere becomes turbulent.

The amount and distribution of heat and other products of combustion are different at different stages of a fire's growth. That is why different methods of attack are needed. A fire stream directed improperly into the area can upset the thermal balance to the point that it hampers fire suppression activities and endangers the fire fighters.

Incipient Fires

During the incipient stages of a fire a direct attack on the fire will cause the convected column to lose its source of heat. The smoke and heated gases will remain at ceiling level where they can be easily removed by normal ventilation efforts.

If, on the other hand, the hose stream is directed at the ceiling overhead the smoke and steam will cool and drop rapidly. The thermal balance is disrupted. Visibility is lost immediately and entry becomes difficult. A similar reaction will occur if a wide fog pattern is directed on the burning fire.

Smoldering Fires

The indirect method is used for a smoldering fire because the burning fuel is not as crucial as the layer of heated gases in the upper portion of the fire area. The fire area must first be ventilated at the highest possible point to provide an avenue of escape for the unburned fire gases and the steam produced by the fire stream. Entry into the fire quickly going into the free burning stage. Entry before ventilation has occurred will result in a backdraft with possible injury to the fire fighters.

A fog pattern should be directed into the superheated atmosphere above the fire. The nozzle should be moved back and forth across the ceiling. The water will quickly evaporate and the steam will displace smoke, heated gases and other products of combustion out through the ventilation hole. The hoseline should not be directed to floor level at this point since premature cooling of this area may complicate the ventilation process by overcooling the lower levels and making the smoke less buoyant.

Free Burning Fires

A free burning fire involving an entire room or structure requires a combination attack. Merely attacking the base of the fire cannot adequately cool the fire and the atmosphere above it. Too wide a fog pattern, on the other hand, will not effectively penetrate the fire area. Cooling only the perimeter of the fire, or failing to cool the entire fire area evenly, will result in turbulence and the presence of hot spots that make extinguishment more difficult.

The first fire stream directed into the area should be relatively narrow and directed overhead as deeply into the fire area as possible. A 30° - 60° fog pattern should then be rotated in a clockwise direction throughout the room. If extinguishment is performed properly, the temperatures in the fire area will continue to fall for some time after open flame production begins to decrease. Smoke and gases that are still warm will be buoyant enough to facilitate ventilation. If the smoke and gases are cooled too much, they will sink to the floor and have to be removed by mechanical means.

Selecting the Appropriate Method of Attack

The primary objective in choosing which method to use is to control the spread of flames and heat as quickly as possible and to confine the fire to the smallest possible area. Generally speaking, the direct method works best up until the point of flashover. After flashover has occurred, the combination method is more effective. Once a fire has gone through a flashover and progressed to a smoldering stage, the indirect method is best.

However, fire is a dynamic event. It can change very quickly from one stage to another. The fire officer must be aware of fire behavior and what is happening to the thermal balance in the fire area. He or she must be able to adapt to the conditions present. As conditions change, so should the application of the fire stream.

Factors Affecting Water Application

Numerous factors affect the application of water on the fire. These factors should be carefully considered when positioning apparatus and deploying hoselines. They include:

- ❑ Fire conditions (fire stage, degree of involvement, amount of heat present)
- ❑ Volume of water needed for extinguishment
- ❑ Reach needed
- ❑ Personnel available to handle hoselines
- ❑ Speed of deployment
- ❑ Type of attack (offensive or defensive)
- ❑ Mobility needed
- ❑ Availability of hoselines (hose diameter and length, nozzle size and type)
- ❑ Location and capacity of pumper
- ❑ Adequacy of water supply (location, pressure and gpm of hydrants)
- ❑ Wind conditions
- ❑ Potential for fire spread

Table 9.1 provides an overview of various hose streams and when they should be used. However, these are basic guidelines only. They are not meant to replace department standard operating procedures or good judgment.

Table 9.1: Hose Stream Characteristics

Size	GPM	Reach (Max.)	# Persons on Nozzle	When Used	Area of Involvement
Booster ¾" - 1"	10 - 30	25' - 50'	1	• Very small interior fire. • No possible chance of extension. • Mop up or overhaul.	Less than one room.
1½" 1¾"	50 - 120	25' - 50'	1 or 2	• Developing fire that can be stopped with a relatively limited quantity of water. • For quick attack. • For rapid relocation of hose streams. • When personnel are limited. • When ratio of fuel load to area is relatively light. • For exposure protection.	One to three rooms.
2½"	150 - 250	50' - 100'	2 to 4	• When size and intensity of fire is beyond the capacity of a 1½" line. • When ample water and personnel are available. • When required for safety of personnel. • When more water or greater reach is required for exposure protection.	One floor or more fully involved.
Master	350 - 2000	100' - 200'	1	• When handlines are insufficient for the size and intensity of the fire. • When water is ample but personnel are limited. • When required for safety and personnel. • When more water or greater reach is required for exposure protection. • When sufficient pumping capability is available. • When massive runoff water can be tolerated. • When interior attack can no longer be maintained.	Large structures fully involved.

Summary

Different methods can be used to extinguish a fire depending on what stage the fire is in. The direct method is used most frequently for fires in their incipient stage. Smoldering fires are best managed with an indirect attack. The combination method should be used for a free burning fire involving an entire room or structure. Applying the proper method of attack is essential for maintaining the thermal balance to both more effectively fight the fire and maintain safety for the fire fighters.

Review Questions

1. For each of the methods of attack listed below, identify what stage of fire it is generally used on and provide a brief description of how it is applied.

Method	Fire Stage	How It Is Applied
Direct		
Indirect		
Combination		

2. What size fog pattern is generally used for the indirect and combination methods?

3. What direction should the fog stream be rotated when applying the combination method? Why?

4. What is meant by the term "thermal balance?"

5. How is it possible to disturb the thermal balance?
   - Incipient fires:
   - Smoldering fires:
   - Free burning fires:

6. Describe how ventilation and fire attack must be timed for smoldering fires.

____

____

____

7. List some of the factors that affect the application of water on a fire.

____

____

____

Topic 10: Protection Systems

Fire protection systems within a structure are a valuable resource to fire fighters during a fire emergency. Detection and alarm systems provide for earlier occupant and fire department notification. Fixed extinguishing systems can slow or stop the fire's progress long before fire fighters arrive on-scene. The presence of a sprinkler or standpipe system can drastically reduce the time and effort needed to perform certain evolutions and operations. The fire officer must have a basic knowledge of these fire protection systems in order to use them effectively during fireground operations.

Automatic Sprinkler Systems

Automatic sprinklers are designed to control a fire in its incipient stage. They provide a highly effective safeguard against the loss of life and property. By rapidly extinguishing a small fire, or confining it to the area of origin, sprinklers drastically reduce the amount of smoke and heat produced. This makes it far easier for people to escape the building. It also reduces the risk to fire fighters who might otherwise be faced with a fully involved structure upon their arrival.

In fact, the NFPA has no record of a multiple death fire (a fire which kills three or more people) in a completely sprinklered building where the system was properly operating, except in the case of an explosion or flash fire, where victims were killed prior to the system's operation. In most cases, victims of fatal fires in sprinklered buildings were either involved in the ignition of the fire and received their injuries prior to the operation of the sprinklers, or were unable to escape due to a physical or mental impairment.

Sprinkler systems also dramatically reduce the amount of damage to the structure and contents. Though there will be some water damage from activation of the sprinkler system, it is far less than the damage that would be done if the fire were allowed to grow unchecked until the fire department could extinguish it.

Types of Sprinkler Systems

There are six major types of automatic sprinkler systems. Each is designed to fulfill a specific purpose.

Wet-Pipe Systems

Wet-pipe systems employ automatic sprinklers attached to a piping system containing water under pressure at all times. When a fire occurs, individual sprinklers are actuated by the heat, and water flows through the sprinklers immediately. This type of system is generally used wherever there is no danger of the water in the pipes freezing, and wherever there are no special conditions requiring one of the other types of systems. Wet-pipe systems are the most common type used in California.

Regular Dry-Pipe Systems

Regular dry-pipe systems have automatic sprinklers attached to piping which contains air or nitrogen under pressure. When a sprinkler is opened by heat from a fire, the pressure is reduced to the point where water pressure on the other side of the dry-pipe valve can force open the valve. Then water flows out of any opened sprinklers. This type of system is used only in locations that cannot be properly heated.

Pre-action Systems

Pre-action systems are dry-pipe systems in which the air in the piping may or may not be under pressure. When a fire occurs, a supplementary fire detection device in the protected area is actuated. This opens a valve that permits water to flow into the piping system before a sprinkler is activated. However, water is not discharged until a sprinkler head is fused. This system gets water to the fire quicker than a dry-pipe system. Yet, because it requires two sources of actuation (a detection device plus the fusing of a sprinkler head) it reduces the risk of accidental water flow. Pre-action systems are designed primarily to protect properties where there is danger of serious water damage if a sprinkler head or pipe should be damaged.

Deluge Systems

These systems are similar to pre-action systems except that all sprinklers are open at all times. When heat from a fire actuates the fire-detecting device, water flows into the system and is discharged from all sprinkler heads simultaneously, thus deluging the protected areas. Deluge systems are designed for extra hazard occupancies where fire might quickly overtake ordinary sprinkler systems. Examples include facilities where flammable liquids or rocket propellants are handled or stored.

Combined Dry-Pipe and Pre-action Systems

These include the essential features of both types of systems. The piping system contains air under pressure. A supplementary heat-detecting device opens the water valve and an air exhauster at the end of the feed main. The system then fills with water and operates as a wet-pipe system. If the supplementary heat detecting system should fail, the system will operate as a conventional dry-pipe system. These are used in locations such as piers where it may be difficult to protect a long supply main from freezing.

Special Types

Special types of systems are sometimes used in situations where the installation of sprinklers is advisable, especially for life safety, even though it is economically or otherwise impractical to meet all the requirements of the NFPA Sprinkler Standard. They may involve water supplies of limited capacity, reduced pipe sizes, partial protection, sprinklers with orifice sizes different from those generally used, and other features not typical of standard installations.

System Components

It is beyond the scope of this course to go into great detail on the components of a sprinkler system. However, the fire officer must be familiar with those components that he or she may have to use or attend to during a fire or other problem involving the sprinkler system.

Water Flow Alarms

Most fire fighters are probably more familiar with water flow alarms than they care to be; a significant number of false alarm calls are due to these devices. There are several types of alarm systems. Some provide a local alarm only. Others transmit a signal to an alarm company or to the fire department. On larger systems, or in facilities with multiple fire protection systems, the alarm will transmit a signal to an annunciator panel to help fire fighters identify the location of a problem.

Control Valves

Every sprinkler system is equipped with a main water control valve and various test and drain valves. Control valves are used to cut off the water supply to the system when heads must be replaced, when maintenance is performed, or when operation must be interrupted. The main control valve should always be returned to the open position after maintenance is completed.

The two most common control valves are the outside screw and yoke valve (commonly called OS&Y valve) and the post indicator valve (PIV). The OS&Y valve has a yoke on the outside with a threaded stem that controls the opening and closing of the gate. The threaded portion of the stem is out of the yoke when the valve is open and inside the yoke when the valve is closed. The PIV is a gate type control valve that has a target marked with the words "Open" and "Shut," one of which will appear in a little window to indicate the status of the valve. These valves are generally located near the main riser that they control, and may be either inside or outside the building.

Water Supply Systems

Sprinkler systems may be supported with water from one or more sources. A connection from a reliable public water works system of adequate capacity and pressure is the preferred single or primary supply for automatic sprinkler systems. Other water sources may include gravity tanks, pressure tanks, and fire pumps that suction water from large reservoirs or sumps.

Fire Department Connections (FDC)

Fire department connections are a standard component of sprinkler systems. This allows the fire department to pump water into the system to boost the pressure and/or volume. If there are two or more sprinkler system risers in the facility, each must have its own FDC. Sometimes they are interconnected, but not always. Fire fighters must be able to accurately determine which connection feeds the riser they wish to supply or they may needlessly delay getting water to the fire. This information should be incorporated into building preplans.

Sprinkler Heads

Sprinkler heads discharge water onto the fire, using a deflector to create a wide spray pattern. There are many different kinds depending on where they need to be located, the hazard(s) or areas they are designed to protect, and the type of system. All employ a cap or plug that is released in response to heat. (The exception is heads used in deluge type systems; they are open at all times.) Sprinkler heads have different temperature ratings based on the maximum temperature expected in the area under normal conditions. *(Table 10.1)*

Table 10.1: Temperature Ratings, Classifications, and Color Codings of Sprinkler Heads

Maximum Ceiling Temperature Expected (°F)	Sprinkler Temperature Rating (°F)	Temperature Classification	Color Code (Color of Frame Arms)

Maximum Ceiling Temperature Expected (°F)	Sprinkler Temperature Rating (°F)	Temperature Classification	Color Code (Color of Frame Arms)
100	135 - 175	Ordinary	Uncolored *
150	175 - 225	Intermediate	White
225	250 - 300	High	Blue
300	325 - 375	Extra High	Red
375	400 - 485	Very Extra High	Green
475	500 - 575	Ultra High	Orange

** Some manufacturers paint the frame arms of their ordinary heads black.*

Fire Department Operations at Sprinklered Buildings

Sprinkler systems are a valuable resource for fire fighters. Whether there is a confirmed fire or not, one of the first arriving units should be assigned to either standby or hook up to the FDC. They must make sure that the FDC is not obstructed. Someone should check to see that the PIV or OS&Y is open. If there is an annunciator panel on the premises, it should be checked to determine the location of the incident. Finally, fire fighters must determine whether or not water is flowing.

Most of the time there are no fires associated with these alarms. But, each one must be treated as if it were a real fire. If there is a fire, or even just a broken sprinkler head, fire fighters will have to take action to prevent needless damage. Just because there is no fire or smoke visible from the exterior of the building upon arrival does not mean that there is not a fire. Remember, the system is designed to control a fire in its incipient stage.

If there has been a fire, fire fighters must approach the area cautiously. It is highly probable that utilities have not yet been shut off, which creates a safety hazard. Sprinkler flow may have disrupted the thermal balance above the fire, resulting in the presence of additional heat, smoke and steam at lower levels than generally encountered.

Fire fighters must also be cautious about shutting down the sprinkler system too early. The fire officer must first be certain that the fire is extinguished or under full control. There must be no chance of a hidden fire burning elsewhere. When a sprinkler control valve is closed, a fire fighter should be stationed at the valve ready to re-open it if the fire should rekindle. Fire fighters can minimize water damage during the time between activation of the sprinkler head and authorization to close the main sprinkler valve by plugging individual heads that are no longer needed for fire extinguishment. This can be done with special sprinkler stops or wooden wedges.

Whenever possible, sprinkler equipment should be restored to full service before leaving the premises. Fused heads should be replaced with new ones of the same type and rating.

Standpipe Systems

Standpipe systems are designed to provide a quick and convenient means of getting water to upper stories in tall buildings or to remote areas of large facilities. They are essentially an "in place hoseline."

There are three different classifications of standpipe systems based on the intended user. *(Table 10.2)* Class 2 standpipe systems are designed for use by building occupants, and should not be used by fire fighters unless for some reason there is no other water supply available. They do not provide the same volume and pressure as a Class I or Class III system. The single jacketed 1½" hoselines are often not well maintained and frequently leak when used.

Table 10.2: Standpipe System Classification

System	Description
Class I	Designed for use by fire departments and those trained in handling heavy hose. Contains 2½" hose connections.
Class II	Provided for use by building occupants until the fire department arrives. Equipped with 1½" single jacketed hoselines and open nozzles or combination spray/straight stream nozzles with shut off valves.
Class III	Combination system equipped with both 2½" hose connections (for use by either the fire department and those trained in handling heavy hose) and 1½" hoselines (for use by the building occupants).

The Class I and Class III systems consist of standpipes that may be 4, 6, or 8 inches in diameter (depending on height and whether or not the building is sprinklered) and 2½" outlets on each floor. The standpipe may be "wet" with water pressure maintained in the system at all times. A wet system may be supplied by one or more sources including the city water works system, automatically or manually controlled fire pumps, pressure tanks, or gravity tanks. Dry standpipe systems do not have water in the lines under normal (nonfire) conditions. They may have an independent water supply, or may rely solely on water pumped through an FDC by the fire department. In either case, the standpipe system permits the connection of standard fire department hoses.

In a combined sprinkler and standpipe system, the sprinkler risers can be used for feeding both the sprinkler system and the hose outlets.

Operation of Standpipe Systems

Just like with sprinkler systems, supplying a standpipe FDC should be the responsibility of one of the first due units. Crews entering the building should take adequate hose to reach the seat of the fire from the floor below. Fire fighters will generally not use outlets on the fire floor unless they have an area of safe refuge, such as a vestibule, to retreat to if conditions become unsafe on the fire floor. Fire fighters should *not* utilize house lines that may be present. They should bring in their own hose and nozzles. If exposures are threatened, it may be necessary to utilize standpipe systems in those buildings also to provide exposure protection.

Automatic Fire Detectors

When people are asleep or buildings are unoccupied, a fire can do extensive damaged before it is ever noticed. Automatic detection devices, particularly when they are tied to an alarm system, can drastically reduce this damage. There are several different types of detectors.

Heat Detectors

Heat detectors respond to convected thermal energy (heat) of a fire. They may respond either when the detecting element reaches a specific temperature (fixed temperature detectors) or to a specified rate of temperature change (rate of rise detector). Heat detectors are the least expensive type and have the lowest false alarm rate. However, they are also the slowest at detecting fires. They are best used in areas where ambient conditions would cause excessive false alarms with other detectors.

Smoke Detectors

Smoke detectors will detect most fires much more rapidly than a heat detector. Since most of our nation's fire victims die from the inhalation of smoke and toxic fire gases, smoke detectors make more sense for most applications. There are three different types of photoelectric smoke detectors, each of which contain a light source and a photosensitive device. Depending on the type, these detectors will either activate when the light source is obscured and less intense at the sensor, or when the light beam is scattered causing the light to strike a sensor that is normally not in the path of the light beam. These detectors generally respond faster to low energy (smoldering) fires that produce larger smoke particles. An ionization smoke detector has a small amount of radioactive material that ionizes the air in the chamber. The detector activates when smoke particles enter the chamber and decrease the conductance of the air. These detectors generally respond faster to high-energy (open flaming) fires that produce large numbers of smaller smoke particles.

Gas Sensing Detectors

Gas sensing detectors detect gases produced by a fire. The semiconductor type actuates when either oxidizing or reducing gases create electrical changes in the semiconductor. The catalytic element type responds to a temperature rise when a material within the detector accelerates the oxidation of combustible gases. These are generally slower to respond than smoke detectors, but faster than heat detectors.

Flame Detection Detectors

Flame detection detectors respond to radiant energy such as flowing embers, coals or actual flames. They are generally only used in high hazard areas where fast detection is required: fuel loading platforms, industrial process areas, hyperbaric chambers, high ceiling areas, and atmospheres in which explosions or very rapid fires may occur. There are two types, infrared and ultraviolet, each of which are sensitive to a slightly different spectrum of light.

Alarm Systems

Far too many lives have been lost and property damaged as a result of delays in calling the fire department. Automatic detection and alarm systems can provide both early warning to building occupants as well as fire department notification. They may be triggered by the presence of heat, smoke, flame, the flow of water in a sprinkler system or tampering with the system.

There are several types of signaling systems, each classified according to the functions that they are expected to perform. *(Table 10.3)* Each has a primary power supply; most also have a back-up power supply. They have one or more initiating device circuits with connection to smoke or heat detectors, manual pull stations, water flow alarms, or other devices. They are also tied to alarm devices such as bells, horns, etc. They may be tied to an annunciator panel located in a lobby, control room or maintenance area.

Table 10.3: Types of Alarm Systems

Type System	Description
Local	Sounds a local evacuation alarm in the protected building only. Designed to alert building occupants. Requires that someone notify the fire department.
Auxiliary	Basically, a local system that has additional circuitry connecting it to the municipal fire alarm system through a nearby master fire alarm box.
Remote Station	Similar to an auxiliary system except that it transmits its signal to a remote location that is attended by trained personnel 24 hours a day. The receiving equipment is usually located at a fire department facility, a police station, or a telephone answering service. If the remote station is not at the fire department, the remote station personnel notify the fire department of the alarm.
Proprietary	Transmits an alarm signal to a central supervisory station operated by someone with a proprietary interest in the protected buildings. The central supervisor station is generally a guard office in or near the protected building(s).
Central Station	Similar to the proprietary system except that the signal is transmitted to a remote central station staffed by operators who perform the service for a fee and have no proprietary interest in the protected building(s).

Supplementary Functions

Many fire alarm systems have other supplementary functions to help control fire and smoke. Some of the more common supplementary functions are as follows:

Smoke Control

Smoke control features are perhaps most common in high rise structures. Simple systems shut down HVAC equipment to minimize the spread of smoke throughout the building. Systems that are more complex may pressurize stairwells or elevator shafts to maintain tenability in areas critical to building evacuation and fire fighting efforts. Some will pressurize locations around the fire area and exhaust the fire area itself to maintain areas of tenable refuge.

It is fairly common both in high rise buildings and large facilities for the alarm system to be tied to automatic fire doors which partition the building into smaller areas. If the smoke does extend beyond the room or area of origin, the fire doors will keep it from spreading horizontally.

Elevator Capture

Elevator capture systems will control the elevators in the event of a fire or an alarm. The systems may be designed to have the elevators bypass a given floor if a smoke detector operated on that floor. They may also be designed to cause all elevators to return to the ground floor and be held there until released by the fire department or authorized building occupant with the proper keys. This system will require building occupants to use the stairways for evacuation. Elevator capture systems are often required in high-rise buildings.

Extinguishing Systems

Some alarm systems are also designed to actuate fixed extinguishing systems such as carbon dioxide, Halon or dry powder systems. They often require the activation of two or more smoke detectors to prevent accidental discharge from false alarms.

Energy Management

Some systems monitor and control HVAC and electrical distribution functions in the building in order to reduce total building energy consumption in the event of an emergency.

Combination Systems

Combination systems may control both some of the features listed above, plus coordinate with other systems such as a burglar alarm or door entry control, background music and employee paging systems.

Fire Department Operations with Alarm Systems

It is easy to become complacent about alarms because of the high number of false alarms that most fire departments respond to. Indeed, most alarm calls turn out to be nothing. However, fire fighters must treat every alarm as if it could be a working structure fire. Once on-scene, the fire officer should check the annunciator panel to determine the type and location of the alarm. (Sometimes this information will be provided by the dispatcher while units are en route.) If it turns out that there really is a fire or other life safety hazard, the fire officer may need to manually activate the building evacuation alarm. That function may or may not be tied into the alarm system.

Some fire departments will assist building owners to reset their alarm systems when it has been determined that there is no fire, or that the fire has been fully extinguished. Other departments require the building owner to reset their own alarms rather than risk damaging a system they may not be familiar with.

Special and Fixed Extinguishing Systems

There are numerous other systems that may be found within a structure. It is beyond the scope of this course to go into detail on those systems. However, the following is a brief overview, with an emphasis how the presence of these systems may affect fire department operations.

Fixed Extinguishing Systems

Fixed extinguishing systems can often be found in those areas where quick extinguishment is desired for the protection of life and property. These systems may include dry chemical, carbon dioxide, or Halon, depending on the area or hazard they are designed to protect. (Information regarding the various extinguishing agents and what types of fires they may be used on was covered in detail in Chapter 8.)

Fixed extinguishing systems may be used in place of automatic sprinklers. However, they are often used in conjunction with sprinkler systems, the automatic sprinklers providing a backup in the event that the fire is not extinguished by the other system.

When responding to a fire where a fixed extinguishing system was discharged, fire fighters need to wear their SCBA. Dry chemical, though nontoxic, will irritate the respiratory system. Carbon dioxide and Halon will both displace oxygen. In addition, Halon will break down upon contact with flame or exposure to sufficient heat, thereby releasing toxic by-products. The concentration of decomposition products will depend on a number of factors including amount of extinguishing agent, the size of the fire, the size of the room, and elapsed time before extinguishment.

Fire fighters must also check to make sure that the fire has been completely extinguished. In cases where there is a deep-seated fire, the continued presence of ignition sources, or where the room is not tightly sealed on a total flooding system, it is possible for the fire to still be burning. It is a good idea to approach the area with a portable extinguisher as a precaution.

Since carbon dioxide and Halon are both heavier than air, it is possible for large volumes of the gas to leak or flow to unprotected lower levels such as cellars, basements, tunnels, or pits. This could create a dangerous oxygen deficient atmosphere. It may be necessary for fire fighters to do some atmospheric testing before entering the area themselves, or allowing anyone else to enter.

The fire officer should also be alert to possibility that building occupants may need to be educated a little about their system. They may have questions about the health hazards of the extinguishing agents or how to put the system back in operation. There may have been problems because a discharge nozzle was blocked or someone hit an override switch when they should not have. By tactfully explaining things to the building owner, the fire officer can possibly prevent a larger fire loss in the future.

Smoke Control Features

There are varieties of construction features that may be incorporated into the building to control smoke movement or assist in ventilating the structure. They include, but are not limited to, smoke curtains, automatic vents, and explosion vents. It is beyond the scope of this particular course to go into detail on these features. However, the fire officer should be aware of occupancies in their jurisdictions that have them. He or she must be able to recognize how they might influence fire behavior within the structure or how they might be used to assist with ventilation.

Utility Controls

Turning off utilities should be done as early as possible in a fire to prevent needless injuries to personnel or damage to the property. Fire fighters need to know how to quickly locate utility shut-offs when they might not be readily visible.

There will be times, however, when it is not a good idea to shut off utilities. Such would be the case in a clandestine drug lab where turning off utilities could provide an ignition source or interrupt a critical cooling process. This may also be a concern in specific industries. Fire fighters need to be familiar with target hazards in their communities that might need to be handled differently.

Summary

This chapter provided a brief overview of the different fire protection systems that fire fighters might encounter, with an emphasis on fire department operations. Most of these systems are designed to provide automatic detection and suppression, but it is generally necessary to either supplement the systems or assist in placing systems back in service before leaving the scene. The fire officer must take these factors into account when performing the size-up so that he or she can assign resources appropriately when determining tactical priorities.

Chapter Review Questions

1. Identify the primary purpose of each of the systems below, and how they will impact fire department operations. What actions will be needed? What precautions should be taken?

   Automatic Sprinkler Systems

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   Standpipe Systems

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   Automatic Detection and Alarm Systems

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   Fixed Extinguishing Systems

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Topic 11: Building Construction

Building construction is a significant factor in both how a fire spreads and how well a building will hold up under fire conditions. The fire officer must understand some of the basic concepts regarding building construction both to safeguard personnel on the fireground and to determine the appropriate fire fighting tactics. The information contained in this chapter provides a brief overview of building construction features.

Construction Types

There are five fundamental types of building construction identified in the Uniform Building Code (UBC) and the Uniform Fire Code (UFC). Each is described briefly below:

Type I (Fire-resistive Construction)

Type I construction (sometimes referred to as fire-resistive construction) contains structural members that are noncombustible and have a high fire resistance rating (generally two to four hours). It is designed to withstand fire exposure without major damage. Monolithic reinforced concrete construction, precast concrete construction, and protected steel-frame construction can all qualify as fire resistive when designed and constructed properly.

While only noncombustible materials are permitted for the structural elements of the building, the use of some combustible materials is allowed for specific applications when they do not add significantly to the fire hazard. Examples may include roof coverings, some types of insulating materials, and limited amounts of wood for interior finish and flooring.

Type I construction often includes limitations on building size, and requirements for automatic fire extinguishing equipment and/or sprinkler systems. These requirements vary with the different occupancies.

Type II (Noncombustible Construction)

Buildings classified as Type II construction are made with materials that do not contribute to the development or spread of fire, yet do not provide the same level of protection as do materials used for Type I construction. These buildings may be metal-framed, metal-clad or concrete-block with metal deck roofs supported by unprotected open-web steel joists.

Because unprotected noncombustible construction cannot withstand fire temperatures for long periods of time without damage or structural failure, it should only be used where the anticipated fire severity is low or where built-in fire protection equipment can be expected to handle the most severe fire that might occur.

Type III (Exterior Protected Combustible Construction)

Type III construction (once called ordinary construction) consists of exterior walls made from noncombustible or limited-combustible materials such as brick, concrete, or reinforced concrete.

Exterior walls are also required to have a degree of fire resistance (with hourly ratings), and exhibit stability when exposed to fire.

Floors, roofs, and interior framing may be made of wood or any other material permitted by the applicable building codes. Floors and structural members may or may not be protected with fire resistive materials. Either way, it is required that all concealed spaces are protected with fire stopping.

Type IV (Heavy Timber Construction)

In Type IV construction, the structural members (columns, beams, arches, floors, roofs, etc.) are made of unprotected wood, either solid or laminated. Very few concealed spaces are permitted; when they are there are very strict requirements. What gives the wood in heavy timber construction its fire resistive rating is the large size of the structural members. It resists failure longer than a conventional wood frame structure because the wood has a smaller surface-to-mass ratio. It takes longer to burn and is relatively slow to conduct heat. Materials other than wood are permitted if they have a fire-resistance rating of at least one hour and are allowed by the applicable building codes.

Bearing walls and bearing portions of walls must be of noncombustible materials, have a fire-resistance rating of two hours or more, and remain stable under exposure to fire. All exterior walls, whether bearing or nonbearing, must be of noncombustible materials.

Type V (Wood Frame Construction)

In Type V construction, the structural members and exterior walls are made entirely of wood or any other material permitted by the particular code. A variety of materials may be used to cover interior and exterior walls. Type V construction is generally more vulnerable to fire, both internally and externally, than any other building type. For this reason, fire stopping within walls and partitions and between floors is important.

Mixed Types of Construction

There are times when two or more types of construction are used within the same building. In situations where this is permitted, additional restrictions are applied to ensure that no additional risks are created by mixing construction types. One common way of handling this is to divide the structure with fire walls or area separation walls having appropriate fire resistance so that each portion may be considered as a separate building. An alternate method is to apply the most restrictive requirements, or those that would be appropriate for the least fire-resistive type of construction.

How Construction Materials are Affected by Fire

All construction materials can be affected by exposure to fire, regardless of fire-resistance ratings. How much a particular material is affected will depend on the intensity of the fire and the duration of exposure. There are chemical changes that contribute to fire spread and emit toxic products of combustion. There are also physical changes caused by contraction and expansion of the materials, which may ultimately result in sufficient distortion to cause structural collapse.

Wood

All wood will eventually burn. However, wood does vary in terms of the amount of fire resistance it provides. Heavy timber construction, due to its size, will maintain its integrity in a fire situation much longer than wood frame construction. Wood, which has been specially treated with a fire-retardant, will withstand exposure to fire for a longer period of time before burning. A higher moisture content in the wood will also provide a little bit more protection. However, wood generally provides less fire protection than most other construction materials.

Gypsum

Gypsum products, such as plaster and plasterboard, are excellent fire protection materials because the high moisture content will absorb a lot of heat as it evaporates. Gypsum products are often used to cover wood frame construction to provide greater fire protection. Gypsum does, however, lose its strength when it gets wet.

Glass

Every building varies in the amount and type of glass used. Glass, in general, provides little resistance to fire because it cracks quickly when heated. Wire-reinforced glass provides somewhat greater integrity in a fire if it is properly installed.

Concrete

There are various different types of concrete, each of which behaves somewhat differently in fire situations. One of the more significant factors is the type of aggregate used in the concrete. Lightweight aggregates, such as expanded shale and expanded slag, have considerably more fire endurance than normal-weight concretes made from carbonate and siliceous aggregates. Another major factor is the moisture content. The more moisture in the concrete, the better it will absorb heat, thus the better it will endure fire. The one drawback is that the evaporation of moisture causes voids in the concrete. High heat or prolonged exposure will ultimately cause the concrete to lose its strength and start spalling. The type of load that the concrete is under will also affect its endurance.

Lightweight concrete, made with noncombustible aggregates, resists high temperatures extremely well. It retains more strength during heat build up than does normal-weight concrete. It also conducts less heat.

Reinforced-concrete structures generally hold up very well under fire conditions. But, when the temperature of a reinforced concrete member is raised, the member loses its strength.

The concrete used for prestressed concrete is of a higher strength than that used in ordinary reinforced-concrete construction; therefore, its overall fire resistance is higher. But, high heat or prolonged exposure can weaken the structure considerably. Prestressed concrete has a greater tendency to spall, exposing the prestressing steel beneath it. The type of steel used for prestressing is more sensitive to elevated temperatures than the steel used in reinforced-concrete construction. It loses its strength at lower temperatures, and that strength is not regained after cooling. The prestressing wires are permanently weakened when they reach a temperature of about 800°F.

Steel

The advantage of steel as opposed to wood construction is that the steel does not burn, nor does it emit products of combustion. However, unprotected steel loses its strength at high temperatures. It is an excellent conductor of heat. And, rapid cooling can cause abrupt failure to load bearing steel.

There are many methods used to insulate or "fireproof" structural steel. It may be encased in concrete, as previously mentioned. The greatest disadvantage to this method is that it adds considerable dead load weight to the structure. Various different surface treatments may be applied such as sprayed-on mineral fibers, cementitious materials, and intumescent paints and coatings. Each has advantages and disadvantages. The greatest concern common to all of them is that if they were not applied properly, or if they have been accidentally or intentionally scraped off for any reason, they no longer protect the steel from fire. The fire officer must take this into consideration when assessing the structural integrity of a burning building.

Another material that had been used for many years to insulate structural steel is asbestos. While asbestos has been removed from many buildings because of the health hazards associated with it, asbestos can still be found in many places. It generally provides a great deal of fire resistance and protection. Probably the greatest concern the fire officer will have to deal with is making sure that fire fighters wear respiratory protection throughout suppression and overhaul stages, and ensuring that appropriate decontamination procedures are followed for protective clothing.

Structural steel may also be protected by suspended ceilings consisting of lath and plaster, gypsum panels, or acoustical tile supported on a grid system. Here again, the overall effectiveness is questionable. Improper installation, or breaches introduced during remodeling or maintenance, will compromise the intended fire protection.

One more method of protecting structural steel is the use of sheet steel membranes over a layer of insulation materials.

Masonry

Brick, tile, and concrete masonry products behave well when exposed to fire. Hollow concrete blocks may crack from the heat, but they generally retain their integrity. Brick can withstand high temperatures without severe damage, however some spalling can be expected.

Building Construction Concerns

There are several concerns that a fire officer must be alert to when evaluating both the potential for fire spread and a building's integrity. Much of it can be attributed to human error. There are times that contractors do not construct a building to code. They may be running behind schedule and trying to save time. They may be running over budget and trying to cut costs. Or, they simply may not understand the importance of the codes, and therefore do not diligently comply with them. A building that is not built to code will not perform as expected during a fire.

Perhaps more common are problems created during reconstruction and remodeling projects. The permit and inspection processes involved in new construction make it possible to catch and correct many potential problems before the building is occupied. Once again, these construction violations will affect a building's performance in a fire.

As time passes, older buildings pose more problems for the fire service. Buildings built to past standards and codes are often inferior in quality and safety features. The construction industry is in constant growth with newer materials and features being incorporated into practice every year.

Common Problems

Some of the most common problems include breached fire walls; holes poked through walls, floors and ceilings; concealed spaces; and fire doors or shutters that are blocked open, broken or removed. Every one of these problems will permit fire and smoke to travel more rapidly to other parts of the building. Remodeled buildings may have an excess of dead loads, which can impact building integrity.

The problems created during construction projects are not limited to increased fire spread. Building occupants may have difficulty evacuating because of blocked exits. These same blocked exits may create access problems for the fire department. There are often many headaches associated with sprinkler systems during construction efforts: loss of fire protection while systems are turned off, broken sprinkler heads, and nuisance water flow alarms.

Other Construction Concerns

There are several other issues that fire officers should be aware of. First, it is important to recognize that buildings will generally reflect the codes that were in existence at the time the buildings were constructed. Upgrading to current codes is expensive. Most building owners will only upgrade their facilities if required by law or their insurance carriers. Many of the requirements for upgrading to newer codes are only applied when the building undergoes extensive remodeling.

Two areas within structures that create additional problems for fire fighters are attics and basements. Fires in either of those areas are usually difficult to access. Both attics and basements may contain considerable storage and fire loading. Fires in attics often spread rapidly as convection preheats the attic space. And, although this increases the damage in any structure, it becomes more of a problem in commercial buildings where multiple occupancies have a common attic. Fire fighters may be exposed to multiple hazards that would otherwise be kept separate.

Fires in basements, on the other hand, often burn for longer periods before being discovered. They can often spread quickly to upper floors through pipe chasers, elevator shafts, and other vertical openings. Basement fires are often very difficult to ventilate; mechanical ventilation is generally required to evacuate smoke from below-grade levels.

There are specific types of structural features that can also be problems for fire fighters. Balloon construction, which was popular at the turn of the century and used up until the 1930s, lacks the fire stopping that would otherwise slow the spread of fire within walls. With arch truss type roofs, the failure of one member can cause a domino effect with the rapid failure of adjacent members. Lightweight construction, with gusset plate trusses, open web trusses and wooden "I" beams, is becoming popular for use in floors and roofs. Tests indicate very quick failure when exposed to heat. Hanging ceilings create concealed spaces that allow hidden horizontal spread of heat, fire, and gases.

Summary

The fire officer must understand some of the basic concepts regarding building construction both to safeguard personnel on the fireground and to determine the appropriate fire fighting tactics. There are five types of building construction identified in the Uniform Building Code (UBC) and the Uniform Fire Code (UFC). Type I provides the highest level of protection, Type V the lowest. Which type of construction is used depends on several factors such as the ability of building occupants to protect themselves and/or quickly evacuate in the event of a fire, the number of occupants, the types of hazards associated with the particular occupancy, and the size and height of the structure.

The various different materials used in building construction can all be affected by exposure to fire. The effects can range from emitting toxic products of combustion to losing structural integrity. Although the fire officer can't actually measure how much damage has been done to a structure, he or she can anticipate potential problems based on how the materials behave when exposed to fire, the approximate intensity (heat) of the fire, and how long the fire is thought to have been burning.

The fire officer must also be alert to problems associated with particular areas within structures or particular types of structures. Attics and basements, for example, are difficult to access and require somewhat different tactics than other areas of a building.

Finally, it is important to recognize that human error can greatly affect both fire spread and a building's integrity. A building that is not built to code, or one which has numerous violations due to reconstruction and remodeling projects, will not perform as expected during a fire. Unfortunately, the fire officer will often not be aware of these problems until a fire occurs.

Chapter Review Questions

1. Briefly, describe each of the five types of construction.

Type	Description
I	
II	
III	
IV	
V	

2. What restrictions may be used to provide protection when two or more types of construction are used within the same building?

3. Under what conditions will wood have a higher degree of fire resistance?

4. What product is often used to cover wood frame construction to provide a greater degree of fire protection?

5. What factors influence how concrete behaves in a fire situation?

6. At what temperature will prestressed steel be permanently weakened?

7. What can happen when load-bearing steel is cooled rapidly?

8. What are some methods used to insulate or "fireproof" structural steel?

9. What are some of the problems associated with remodeling projects?

10. What are some of the problems associated with attics and basements?

Topic 12: Occupancy Types

Understanding occupancy types is important to the fire officer when sizing-up an emergency scene. It allows the fire officer to make some general assumptions about such things as occupant load, exiting capacity, fuel loading, and construction and fire protection features.

How Occupancy Type Impacts Fire Department Operations

Occupancy type will influence fireground priorities to some extent. A fire in an occupied public assembly will generally present more complex rescue problems than a fire in a storage facility. A fire in a facility with hazardous materials will need to be managed differently than one in a residential occupancy.

The occupancy type is often a factor in determining the structural components of construction. Codes require specific construction types based on planned occupancy. This reduces the risk to occupants in case of a fire. However, problems can occur when the occupant moves out and is replaced with another occupant whose operations present a greater degree of risk than the original designs called for. This compromises the fire department's ability to adequately protect the new occupants.

The type of occupancy will also help the fire officer anticipate the type of occupants most likely to be encountered and the amount of assistance they will require. We can categorize occupants as either "controlled" or "uncontrolled." *Controlled occupants* are those who are closely managed such as prisoners, hospital patients, and school children. The employees in these facilities are usually responsible for initial evacuation procedures, making the fire fighter's job a little easier. *Uncontrolled occupants* are nearly everyone else, including those in residential, assembly, and business occupancies. If, for some reason, these occupants are unable to evacuate by themselves, they will require direct fire department assistance.

Of course, there can be many variables with any fire situation. The good fire officer uses this information as a foundation only, not as an absolute. A building may be rated for an occupant load of less than 50 people, but that does not mean that there will not be more people inside. A building owner may be using and storing hazardous materials illegally. Fire protection features may not function as designed. There are no guarantees about what fire fighters will actually find when they arrive on-scene. However, having this knowledge base takes some of the guesswork out of the process.

Understanding occupancy types is also important during company inspections because the requirements often vary based on occupancy. What may be safe in a hazardous (H) occupancy that was specifically designed for that purpose might be unacceptable in a business (B) occupancy. The requirements are often less stringent for facilities with occupant loads of less than 50 than for those that accommodate more people. Although the fire officer may not have to be intimately familiar with the various occupancy types and their specific requirements, he or she must be able to recognize that there are differences and know where to go for more information.

Specific Occupancy Types

An "occupancy" is the purpose for which a building, or part thereof, is used or intended to be used. They are arranged into groups or classifications based on their similarities of usage. Table 12.1 shows the ten different occupancy types.

Table 12.1: Occupancy Groupings

Group	Occupancy Type
A	Assembly
B	Business
E	Educational
F	Factory
H	Hazardous
I	Institutional
M	Mercantile
R	Residential
S	Storage
U	Other

Table 12.2 provides more detailed descriptions of the occupancy types by group and division.

Note: Occupancy groupings have changed in recent years. This information comes from the 1994 Uniform Fire Code, Table 3-A. Complete descriptions can be found in Section 216 of the Uniform Fire Code.

Table 12.2: Occupancy Classification Descriptions (By Group and Division)

Group A • Assembly	
A-1	A building or portion of a building having an assembly room with an occupant load of 1,000 or more and a legitimate stage.
A-2	A building or portion of a building having an assembly room with an occupant load of less than 1,000 and a legitimate stage.
A-2.1	A building or portion of a building having an assembly room with an occupant load of 300 or more without a legitimate stage, including such buildings used for educational purposes and not classed as a Group E or Group B Occupancy.
A-3	Any building of portion of a building having a assembly room with an occupant load of less than 300 without a legitimate stage, including such buildings used for educational purposes and not classed as Group E or Group B Occupancy.
A-4	Stadiums, reviewing stands and amusement park structures not included within other Group A Occupancies.

Group B • Business	
B	A building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts, and eating and drinking establishments with an occupant load of less than 50.
Group E • Educational	
E-1	Any building used for educational purposes through the 12th grade by 50 or more persons for more than 12 hours per week or four hours in any one day.
E-2	Any building used for educational purposes through the 12th grade by less than 50 persons for more than 12 hours per week or four hours in any one day.
E-3	Any building or portions thereof used for day-care purposes for more than six persons.
Group F • Factory	
F-1	Moderate-hazard factory and industrial occupancies including factory and industrial uses not classified as Group F, Division 2 Occupancies.
F-2	Low-hazard factory and industrial occupancies including facilities producing noncombustible or nonexplosive materials which during finishing, packing or processing do not involve a significant fire hazard.
Group H • Hazardous	
H-1	Occupancies with quantity of material in the building in excess of those listed in Table 3-D that present a high explosion hazard as listed in Section 307.1.1.
H-2	Occupancies with quantity of material in the building in excess of those listed in Table 3-D which present a moderate explosion hazard or a hazard from accelerated burning as listed in Section 307.1.1.
H-3	Occupancies with quantity of material in the building in excess of those listed in Table 3-D which present a high fire or physical hazard as listed in Section 307.1.1.
H-4	Repair garages not classified as a Group S, Division 3 Occupancies.
H-5	Aircraft repair hangers and heliports not classified as Group S, Division 5 Occupancies, and heliports.
H-6	Semiconductor fabrication facilities and comparable research and development areas when the facilities in which hazardous production materials are used, and the aggregate quantity of material is in excess of those listed in Table 3-D or Table 3-E.
H-7	Occupancies having quantities of materials in excess of those listed in Table 3-E that are health hazards as listed in Section 307.1.1.
Group I • Institutional	
I-1.1	Nurseries for the full time care of children under the age of six (each accommodating more than five children), hospitals, sanitariums, nursing homes with nonambulatory patients, and similar buildings (each accommodating more than five patients).
I-1.2	Health-care centers for ambulatory patients receiving outpatient medical care which my render the patient incapable of unassisted self-preservation (each tenant space accommodating more than five such patients).
I-2	Nursing homes for ambulatory patients, homes for children six years of age or over (each accommodating more than five persons).
I-3	Mental hospitals, mental sanitariums, jails, prisons, reformatories, and buildings where personal liberties of inmates are similarly restrained.

Group M • Mercantile	
M	A building or structure, or portion thereof, for the display and sale of merchandise, and involving stocks of goods, wares or merchandise, incidental to such purposes and accessible to the public.
Group R • Residential	
R-1	Hotels and apartment houses, congregate residences (each accommodating more than 10 persons).
R-2	Not used.
R-3	Dwellings, lodging houses, congregate residences (each accommodating 10 or fewer persons).
Group S • Storage	
S-1	Moderate hazard storage occupancies including buildings or portions of buildings used for storage or combustible materials not classified as Group S-Division 2 or Group H Occupancies.
S-2	Low-hazard storage occupancies including buildings or portions of buildings used for storage of noncombustible materials.
S-3	Repair garages where work is limited to exchange of parts and maintenance not requiring open flame or welding and parking garages not classified as Group S, Division 4 Occupancies.
S-4	Open parking garages.
S-5	Aircraft hangers and helistops.
Group U • Other	
U-1	Private garages, carports, sheds, and agricultural buildings.
U-2	Fences over 6 feet (182.9 mm) high, tanks and towers.

Occupant Loading

Maximum occupant loading varies by occupancy classification. Occupant load factors for various occupancies can be found in Table 10-A in Uniform Fire Code and Table 33-A of the Uniform Building Code. These load factors are based on a minimum allowable square footage for each occupant. *(Table 12.3)*

In order to determine the maximum occupant loading, it is necessary to divide the usable square footage of the building or room in question by the occupant load factor. For example, a 1000 square foot auditorium without fixed seating should have a maximum occupant load of 142 people. (The occupant load factor listed in Table 10-A of the UFC is seven square feet per person. 1000 divided by 7 is approximately 142.)

Once again, the fire officer cannot always count on these occupant loads. Places of public assembly, unfortunately, sometimes exceed their occupant loads in order to avoid turning away business. After all, the more customers they bring in, the more money they make. This just gives the fire officer a foundation from which to work.

Table 12.3: Occupant Load Factors

Occupancy Type	Occupant Load Factor (Square Foot per Person)
Aircraft hangers (no repair)	500
Auction rooms	7
Assembly areas, concentrated use (without fixed seats)	
• Auditoriums, churches and chapels, dance floors, lobby accessory to assembly occupancy, lodge rooms, reviewing stands, stadiums	7
• Waiting area	3
Assembly areas, less-concentrated use Conference rooms, dining rooms, drinking establishments, exhibit rooms, gymnasiums, lounges, stages	15
Bowling alley (assume no occupant load for bowling lanes)	Occupant load based on 5 persons for each alley including 15 feet of runway
Children's homes and homes for the aged	80
Classrooms	20
Congregate residences	200
Courtrooms	40
Dormitories	50
Dwellings	300
Exercising rooms	50
Garage, parking	200
Hospitals and sanitariums, health-care centers, nursing homes	80
Hotels and apartments	200
Kitchen - commercial	200
Library reading room	50
Locker rooms	50
Malls	Not specifically listed. Varies with each individual occupancy within the mall.
Manufacturing areas	200
Mechanical equipment room	300
Nurseries for children (day care)	35
Offices	100
School shops and vocational rooms	50
Skating rinks	50 on the skating area; 15 on the deck
Storage and stock rooms	300

Occupancy Type	Occupant Load Factor (Square Foot per Person)
Stores - retail sales rooms	
• Basements and ground floor	30
• Upper floors	60
Swimming pools	50 for the pool area, 15 on the deck
Warehouses	500
All others	100

Fuel Loading

Fuel loading is defined as the amount of fuel available to the fire. It includes both the structure and its contents. Having a basic understanding of fuel loading is important in determining the type and amount of fire fighting resources needed to extinguish the fire.

Fuel load is determined largely by the type of occupancy. Table 12.4 provides an overview of the types of occupancies considered to have light, moderate or heavy fuel loads.

Table 12.4: Approximate Fuel Loading Based on Type of Occupancy

Light Load (5-10 lbs./sq. ft.)		Moderate Load (10-20 lbs./sq. ft.)	Heavy Load (>20 lbs./sq. ft.)
Offices	Restaurants	Retail Shops	Warehouses
Hotels	Public Libraries	Factories	Bulk Storage Facilities
Hospitals	Institutional Buildings	Workshops	
Schools	Administrative Buildings		
Museums			

These are general guidelines only. Many variables can and often do exist. For example, mercantile occupancies may have a much higher load depending on the type and amount of material stored. They generally have higher fuel loads during the holiday season.

Annual company inspections are one good way for fire officers to familiarize themselves with the different facilities in their jurisdiction, as well as the types and amounts of fuel loading found within the buildings. They seldom have that opportunity during an actual fire.

Summary

Understanding occupancy types allows the fire officer to anticipate some of the problems crews may encounter in a fire situation, as well as some of the fire protection features which may assist them in their suppression efforts. This chapter provided an overview of occupancy types, occupant loading, and fuel loading.

Chapter Review Questions

1. Give some examples of information a fire officer can anticipate if he or she understands occupancy types.

2. List the ten different occupancy types

Group	Occupancy Type

3. What table in the 1994 UFC describes occupancy types?

4. Where can you find occupant load factors?

____

____

____

5. What is the primary factor in determining fuel load?

____

____

____

6. List some examples of occupancies with:

Light fuel loads: ______________________________

Moderate fuel loads: ______________________________

Heavy fuel loads: ______________________________

Activity 12-1

TITLE:	Occupancy Load Limitations
MATERIALS NEEDED:	• Table 12.2 • Table 12.3
DIRECTIONS:	1. Answer the following questions. 2. Be prepared to discuss your answers with the class.

1. Identify the occupant load limitations generally associated with the occupancy type listed.

Occupancy Type	Occupant Load	Occupancy Type	Occupant Load
A-1		E-1	
A-2		E-2	
A-2.1		E-3	
A-3		I-1.1	
B		I-1.2	
R-1		I-2	
R-3			

2. What is the maximum occupant load that you would normally expect to find in the following occupancies?

Occupancy Type	Size (Square Feet)	Maximum Occupant Load
Auditorium (no fixed seats)	10,000	
Restaurant	1,700	
Church	2,500	
Library Reading Room	6,000	
Nursery for Children (Day Care)	750	
Dance Floor	1,500	
Theater Lobby Area	500	
Classroom	700	
Conference Room	325	
Retail Store (Ground Level)	2,600	

Topic 13: Prefire Planning

Of all the resources available to the fireground officer, the information contained within a current prefire (or pre-incident) plan is possibly the most valuable. When decisions are based on inadequate data, the fire officer loses the opportunity to quickly implement an efficient plan of operation. Prefire plans allow the officer to base decisions on a higher percentage of "knowns" as opposed to "unknowns."

Types of Preplans

Although preplans may be similar from one department to the next, there really is no uniform standard. And, preplans may vary greatly depending on the need.

Hazard Listing

One very simple form of preplan is a hazard listing. It is designed to identify the type and location of specific hazards to fire fighters and building occupants. It is geared primarily for those facilities with hazards that should be documented to facilitate determining a plan of operation, but that do not require a lot of detail. The information is usually very brief and simple.

Site (or Block) Preplans

Site preplans are similar to "run cards" that a department might use, except that they are specifically geared towards large complexes such as shopping centers, industrial parks, trailer parks, and apartment or condominium complexes. They are designed to show access routes, as well as anything that might hamper access such as railroads, fences, walls, overhead obstacles, and areas where the street width or turning radius is inadequate. They will also show hydrants, fire department connections, and utility shut-offs for the complex if applicable. They generally do not provide information on specific occupancies.

Occupancy Preplans

The occupancy preplan is the most specific kind. It provides a detailed analysis of the specific occupancy. It will include occupancy type, data on the occupants themselves (particularly in those facilities where the occupants may be unable to protect themselves in the event of an emergency), fire loading, and construction features. The occupancy preplan generally includes a site map highlighting any specific hazards or concerns at the facility.

Combination Plans

There are many times when more than one type of preplan is appropriate. An industrial complex, for example, may require all three. A combination of a site plan and occupancy plan might be more appropriate for a shopping center. The important thing is that a department's preplanning process be flexible enough that it can be adjusted to meet the needs of any facility.

Hazardous Materials Management Plans

There are two other types of plans worth mentioning. These are the hazardous materials inventory statements (HMIS) and the hazardous materials management plans (HMMP). These are required to be developed and maintained by personnel at facilities that store hazardous materials. A copy must be given to the agency having emergency response authority.

Prefire Information

The amount of data contained in a prefire plan can be enormous. It is important when drafting a prefire plan that the author determines just what is of immediate importance and what is not. This is a basic plan that must be easy to use in the field. One must weigh the "nice to know" versus the "need to know." The following are some of the most important things to include on a preplan:

- ❑ Construction type and features
- ❑ Occupancy type and features
- ❑ Prediction of fire behaviors
- ❑ GPM availability and requirements
- ❑ Identification of hazards to personnel
- ❑ Units and staffing within the response assignments
- ❑ Anticipated fire fighting problems
- ❑ Anticipated strategical objectives
- ❑ Protection systems
- ❑ Plot and floor plans

Information Which May be Included on a Prefire Plan

The following information contains a more detailed list of items that might be included on a prefire plan. However, this is just a list of possibilities. Most preplans will not require this much information. Sometimes time most effective way to build the prefire plan is to start with the most important details, adding less important items as appropriate until you reach a balance where the plan looks complete, yet uncluttered.

The Occupancy and Responsible Parties

- ❑ Occupancy type
- ❑ Occupant load
- ❑ Fuel load (fire load)
- ❑ Responsible party
- ❑ Emergency contacts

- ❑ Emergency phone numbers

Construction Features

- ❑ Age of building
- ❑ Structural materials
- ❑ Construction design
- ❑ Roof construction
- ❑ Building dimensions
- ❑ Compartmentation
- ❑ Fire walls and hour rating
- ❑ Fire doors
- ❑ Stairwells (enclosed or not)
- ❑ Construction shortcomings
- ❑ Building ventilation systems
- ❑ Auto ventilators and roof openings
- ❑ Plot plan

Access Concerns

- ❑ Street and building access
- ❑ Street conditions - traffic problems
- ❑ Methods of entry
- ❑ Methods of egress
- ❑ Lock boxes
- ❑ Elevator keys

Water Supply

- ❑ Required fire flow
- ❑ Main size
- ❑ Available hydrants
- ❑ Main pressure and available GPM

Fire Protection Features/Systems

- ❑ Fire detection systems
- ❑ Indicator (annunciator) panels
- ❑ Sprinkler systems

- ❑ Riser location and size
- ❑ PIV
- ❑ Fixed extinguishing systems

Other On-site Resources

- ❑ Auxiliary power
- ❑ Fire brigade or emergency response team
- ❑ Security officers
- ❑ Maintenance supervisor
- ❑ Technical experts
- ❑ Building communications systems

Special Hazards

- ❑ Hazardous materials
- ❑ Hazardous processes
- ❑ Pressurized cylinders
- ❑ Confined spaces (entry permits required)
- ❑ Overhead electrical wiring
- ❑ Special equipment required
- ❑ Special protective clothing required

Emergency Response Considerations

- ❑ Distance and Time of Response
- ❑ Access Routes
- ❑ 1st and 2nd Alarm Assignments
- ❑ Response Capabilities (Personnel and Equipment)
- ❑ Training Level of Response Personnel
- ❑ Time of Day Considerations
- ❑ Exposure Problems
- ❑ Past Fire History
- ❑ Available Staging Area
- ❑ Command Post
- ❑ Usual Wind Directions

- ❑ Geographic and Topographical Concerns
- ❑ Location of Utility Shut-off Valves
- ❑ The Effects of Shutting Off Utilities
- ❑ Radio Problems
- ❑ Predetermined Objectives

Other Miscellaneous

- ❑ Hospital triage teams (type, location, and response time)
- ❑ Heat Net - O.C.C. - P.D.

Target Hazards

Every community has what they call "target hazards." In general, these target hazards can be described as occupancies or areas that present a greater degree of risk and/or will require extraordinary efforts to control an emergency. A "working" incident at one of these target hazards might automatically receive a second alarm or mutual aid assignment, or specialized equipment such as a Haz Mat unit. Table 13.1 provides an overview of some of the typical target hazards that a community might have.

Table 13.1: Typical Target Hazards

Criteria	Examples
Any occupancy that presents a high risk to life safety (either due to the condition of occupants or the number of occupants).	Hospitals, convalescent homes, jails, hotels, apartment complexes, high rise buildings, places of public assembly, schools and large day care centers, large restaurants, airports.
Any place where large quantities or particularly dangerous hazardous materials are used or stored.	Bulk chemical storage facilities, production and manufacturing facilities, research and development facilities, biotech companies, airports, and hospitals.
Any occupancy where there are highly concentrated property values.	Shopping malls, warehouses, computer centers.
Any place where large quantities of water would be required for fire fighting operations.	Bulk storage yards, lumberyards, and industrial complexes.
Any area where there is a potential for the development of a conflagration.	Large residential tracts with wood-shingled roofs, closely built occupancies of combustible construction, urban interface areas.
Any area or occupancy that creates access or operational problems.	High rise structures, large apartment complexes, unusually shaped or interconnected buildings, bridges, freeways.
Any specific occupancy with a high frequency of fire occurrence.	This can usually be determined by an analysis of fire department records.

Again, these are just examples. Each jurisdiction will have its own definition of what a target hazard is.

Often the responsibility for preplanning these facilities is divided between line personnel and specialists within the fire prevention bureau. The specialists may have a higher degree of technical knowledge regarding applicable codes, hazardous materials, or emergency planning on a community level. However, it is absolutely essential that line personnel be involved in the preplanning process because they are the ones who will be first-in when an emergency occurs.

The preplans for these target hazards are generally more involved than for other facilities within the jurisdiction. Development of these plans generally requires a lot of preparation, research, site visits and inspections, and completion of detailed forms and maps.

Use of Preplans

Preplans can be invaluable to response personnel at an incident. They provide vital information regarding the occupancy that may have a direct bearing on the fire officer's tactics and strategy. From a nuclear facility to a prison, the fire officer must have first hand information regarding the operations, building layout and construction, contents (particularly hazardous materials), and utility controls.

It is essential that preplans be easily accessible. They will not do the fire officer any good if they are locked up in the fire prevention office. Each department has different protocols regarding where these plans are kept. Some maintain preplans on each engine. Others keep their preplans with the battalion chiefs. It will not be long before some departments carry their preplans on computers within their response vehicles.

The preplans should be written in a style that is easy to both understand and see in poor lighting conditions. The format must be clear and concise. The printing should be bold and large. The odds of having to quickly find information on these preplans under poor conditions are pretty good. Where symbols are used they should be easily understood, and possibly even colored so that they stand out.

The plans must be updated on a regular basis, and certainly whenever there are changes in the occupancy. Out of date information or maps defeat the purpose of having preplans. All personnel who may respond to an incident at a particular occupancy should review these plans each time they are updated. Preplans should also be used during company drills so that response personnel can become proficient at using this "tool" as part of their fireground operations.

Developing the Preplan

Every department has its own procedures for developing prefire plan, and all personnel should be familiar with those procedures. The following are just a few basic guidelines. All personnel must understand what kind of preplan is needed for the facility and what types of information is needed for the plan. This may require input from both the fire prevention bureau and the fire fighters on the line. Included in this chapter are just two examples of prefire survey forms that can be used. Most departments develop their own.

The person(s) responsible for creating the preplan should do as much research ahead of time as possible. It is important to remember that other people's time is very valuable to them. It is good public relations for the fire department to be prepared so that we do not waste someone else's time unnecessarily. This preparation includes reviewing existing preplans if there are any, reviewing applicable fire and building codes, and being familiar with the hazards associated with site operations or the chemicals in use at the facility.

Pre-incident Survey Data Collection Form

Pre-incident #: ______________________ Address: ______________________

GENERAL INFORMATION

Building Name: ______________________

Lock Box: ______________________ Lock Box Location: ____________

Contact Person: ______________________ Emergency Telephone: ____________

CONSTRUCTION FEATURES

Roof Type: ____________ Material: ________ Elevator: ________

Exterior Walls: ____________ Fire Wall Rating: ________ Building Age: ________

Attic Access: ____________ Basement Access: ________

FIRE FLOW

	WIDTH	LENGTH	SQ. FT.	HEIGHT	STORIES	LOAD	100%	75%	50%	25%
Target Building			X				Calculated by computer			

BUILT IN PROTECTION

Sprinkler System: ________ Standpipe System: ________ # of Risers: ________

Partial System: ________ Area Covered: ________

FDC Location: ________

PIV Location: ________

OS&Y Location: ________

Alarm Type: ________ Company Name: ________ Telephone: ________

LIFE SAFETY

Day Shift: ______ Swing: ______ Night: ______ Maximum Occupant Load: ______

Nonambulatory: ______ Blind: ______ Deaf: ______ Handicapped: ______

HAZARDOUS MATERIALS

OES Reference #: ______________________

Chemical Information:

Hazard ________ Quantity ________
Health
Flammability
Reactivity

ADDITIONAL INFORMATION

____

EXPOSURES

North: ________ East: ________ South: ________ West: ________

FIRE FIGHTER HAZARDS

____

Completed: ______________ Revised: ______________ By: ______________

Sketching Form

Pre-incident Survey Data Collection Guide Sheet

This guide sheet is designed to assist with gathering data at the target building. Each field of the Pre-incident Survey Data Collection Form is covered in order.

General Information

This section is self-explanatory. Keep description of lock box very brief.

Construction Features

Roof Type:	Major roof styles: flat, butterfly, shed, hip, pitched, mansard, modern mansard, lantern, gambrel, arch
Material:	Roofing material: plywood, shake, slate, tile, composition, gravel, metal, hop mop, and concrete.
Elevator:	Yes or no.
Exterior Walls:	Wood, metal clad, concrete block, concrete, brick, veneer
Fire Wall Rating:	1, 2, 3, 4-hour or none.
Building Age:	Choose either pre-1933 or post-1933 (easily determined by construction style).
Attic Access:	Keep description very brief.
Basement Access:	Keep description very brief.

Fire Flow

Target:	Include dimensions for the specific business you are surveying on this line.
Building:	If the target business sits in a complex or contacts other structures, include the total area of the whole building. If the target business is free standing, leave these fields empty.
Dimensions:	Self-explanatory.
Square Feet:	Calculated by computer.
Load:	Determined by officer discretion based on amount of combustibles adding to fire load of target. (Light, Medium, and Heavy)
GPM Requirement:	It is important for the purpose of fireground resource management that determination be made on the requirements for water needs. Many professional fire officers today recognize the need for a somewhat scientific system for determining fire flow. It is recognized, however, that there is not time for complex computations as a fast moving fire. For this reason, a system for quick calculations will be utilized. Most of us are familiar with the cubic foot formula: length times width times height equals gallons per minute (L x W x H = GPM). The formula has been validated through years of use. It is based upon the fact that a gallon of water

will inert 200 cubic foot space when converted to steam. Therefore, we will calculate this figure and reference it on the pre-incident plan form. This is an estimation only; once the water is deployed, the officer in charge measures the effect and either continues with that amount or adds more. The computer will calculate for 100%, 75%, 50%, and 25% involvement of target and the complete building, if applicable.

Built In Protection

Sprinkler System: Yes or no.

Standpipe System: Yes or no.

# of Risers: List the number of risers, if applicable, to assist in mapping the sprinkler system and in finding risers if necessary to shut down the system.

Partial System: Yes or no. If yes, indicated area(s) covered.

FDC, PIV, OS&Y: Indicate locations. Make sure these are also drawn and boldly identified on your plot plan drawing.

Alarm Type: Alarm type, company name and phone number are important when it is necessary to call the alarm company to reset the system.

Life Safety

Shift and Load: Use these spaces to indicate how many people might normally occupy the building on each shift, plus the maximum occupant load. This gives the fire officer some information regarding whether or not the building might be occupied at the time of a response, plus the approximate number of people who might be present.

Handicaps: Use this line to indicate any conditions (nonambulatory, blind, deaf, other handicaps) that might suggest the need for evacuation assistance.

Hazardous Materials

Chemical Info: This area is set aside for the identification of any hazardous materials the occupancy may possess. It gives the names and hazard listings of materials that may either cause injury to response personnel or require special mitigation measures.

Additional Information

Additional Info: This area is set aside for any unusual or important items not covered elsewhere in the form. Examples include the presence of guard dogs, government secret materials, or anything requiring exceptional handling.

Exposures

Exposure Distances: Distance in feet to the nearest exposures on all sides.

Fire Fighter Hazards

Fire Fighter Hazards: Indicate any other potential hazards not already listed.

Other

Completed: Indicate date completed.

Revised: Indicate date of last revision.

By: Name of person completing the preplan.

Pre-incident Survey

General Information		
Occupancy Name:		Occupancy Type:
Address:		Map Page:
Contact Person:	Phone:	Emergency Phone:

Life Safety			
Hours Occupied:		Maximum Occupant Load:	
Anticipated Occupancy - Weekdays:	Swing Shift:	Nights:	Weekends:
Condition of Occupants (Indicate if there are occupants who may need special assistance during an emergency such as nonambulatory, handicapped or elderly persons, or very young children.)			

Building Description
Building Description. Include information regarding building size, construction type and materials, and access. Attach a site map(s) as appropriate.

Fire Protection Systems

Type System	**Yes**	**No**	**Area Protected, Location of Controls, Comments**
Sprinkler			
Standpipe			
Dry Chem, CO_2, Halon			
Smoke/Heat Detectors			
Alarm			
Annunciator			
Bldg. Communications			
Other			

Resource Requirements

% Involvement	Required Fire Flow	Units Recommended: Engine	Truck	Haz Mat	Chief Officer	Other
25%						
50%						
75%						
100%						

Fire Behavior, Problems and Hazards

Fuel Load (light, moderate or heavy):

Fire Behavior Predicted:

Problems Anticipated:

Exposures:

Hazards to Fire Fighters:

Hazardous Materials

Chemical and/or Trade Name	UN #	MSDS (Y/N)	NFPA 704 H	F	R	Special	Quantity	Class

Additional Comments

Additional Comments:

Completed by: Date:

The business owner or other appropriate representative should be contacted in advance so that a site visit can be scheduled at a time which is convenient for all parties. If it is possible that they will need to do some research of their own to provide the fire department with specific information, they should be informed ahead of time. That way they can have the information ready when fire fighters arrive. The following is an example of a letter that can be sent to business owners or managers before conducting a pre-incident survey of their property.

When it comes time to tour the facility, it is recommended that the business owner or representative accompany the fire department on the inspection. It gives fire fighters the opportunity to ask questions as they arise, plus makes it possible to access areas that might normally be kept locked. It is also another good opportunity to build public relations because fire fighters can talk to the business owner about specific hazards within the facility and how to make operations safer for employees. They can also use this time to educate the business owner about how they will respond to an emergency at the facility.

Generally, fire fighters will create a rough draft of the preplan during the site visit, and then clean it up back at the station. Many preplans are now developed on computer so that they look neat and professional, and so that they can be easily updated as things change at the facility. It also makes it possible to easily reproduce the preplans so that they can be stored in several locations. The sample plot plan and floor plan below were drawn on computer. Notice that while the same thing can be accomplished by making copies of schematic drawings from a blueprint, this illustration is much cleaner and easier to use in an emergency.

Sample Plot Plan and Floor Plan

Summary

Prefire plans can be an invaluable "tool" to response personnel at an emergency scene. They often provide vital information regarding an occupancy that may have a direct bearing on the fire officer's tactics and strategy.

There are various different kinds of preplans, each of which is designed to provide different kinds of information. The size and complexity of an occupancy will dictate which kind of preplan is needed. One must weigh the "need to know" versus the "nice to know" when developing a preplan because there is a lot of information that can be incorporated into those documents. Preplans must contain enough information to be useful, but not so much information that they become difficult to work with. Target hazards, occupancies or areas that present a greater degree of risk and/or will require extraordinary efforts to control an emergency, generally require more detailed preplans and a lot more involvement from different people within the fire department.

Finally, preplans are only of value when they are easily accessible and everyone is familiar with them. The use of preplans should be incorporated into company drills so that response personnel can become as proficient at using this resource on the fireground, as they are any other tool.

Chapter Review Questions

1. How can a good fire plan benefit the fire officer at an emergency scene?

   ____

   ____

2. List the five types of preplans identified in this chapter and give a brief description of each.

Type	Description

3. Who is responsible to develop hazardous materials inventory statements (HMIS) and hazardous materials management plans (HMMP)?

   ____

4. List some of the key things that should be included on a preplan.

5. What is a "target hazard"? Give some examples.

6. What are some guidelines for making preplans easy to use?

7. What are some basic guidelines regarding how to effectively develop preplans?

Topic 14: Fire Data

Every fire officer has a responsibility to document emergencies, both to provide a record of the incident and to contribute to statistical databases. Not everyone enjoys doing the paperwork that goes along with the job. But, ultimately, it *does* benefit the fire officer. Understanding how this information is used, and knowing how to properly complete the documentation, becomes very important.

The Incident Report (or Fire Report)

While reporting procedures vary from one department to another, it is essential that all fire departments have some procedure in place to document emergency responses. The report should provide information about what caused the incident, what contributed to any escalation of the incident, emergency procedures undertaken and the results of those operations, and a description of the casualties of the damage resulting from the incident.

There are three basic reasons for documenting incidents. The first is just to provide a legal record of the incident. This is particularly important if an incident might end up in court some day. Second, it helps to keep upper management informed of activities within the department. Finally, the report provides a means to develop a database of information regarding emergency incidents and fire department responses.

NFIRS and CFIRS

The U.S. Fire Administration (USFA), within the Federal Emergency Management Agency (FEMA), has developed the National Fire Incident Reporting System (NFIRS). It is now being used in 40 states, and annually collects data on approximately one million fires from more than 13,400 fire departments.

Data is collected on a number of different types of incidents. Computer programs are used to manage the database and to generate reports showing a variety of statistics. This database is also available to businesses or individuals who wish to perform their own analyses.

The California Fire Incident Reporting System (CFIRS) is the state equivalent of NFIRS. It was developed by the California State Fire Marshal with the assistance of the CFIRS Advisory Committee, composed of representatives from both large and small, paid and volunteer fire departments in the state. The CFIRS program contains basic information "fields" required by the State Fire Marshal. However, each department can customize their own records to include information that might be important to them locally.

Each time a fire service unit moves in response to an alarm, an incident report (CFIRS-1) is completed. The CFIRS-2 section is used to report injuries or deaths of fire service personnel that occur in conjunction with any incident response. CFIRS-3 is used to report injuries or deaths to civilians or other emergency personnel such as police officers or ambulance attendants. (See Figures 14.1 and 14.2 for copies of these forms.) Another form, CFIRS-HazMat (or Hazardous Materials Incident Report), is used to report incidents involving hazardous materials.

The completed CFIRS reports (on diskette, magnetic tape or hard copy) are sent by each fire department to the State Fire Marshal's Office not less than quarterly. This information is entered into their computer system, and then compiled in an annual report showing statewide trends. The statewide data is tabulated and sent to the Federal Emergency Management Agency through the U.S. Fire Administration for compilation with other states' data.

NFPA 901, Uniform Coding for Fire Protection

To maintain uniformity in fire reporting, the NFPA Technical Committee on Fire Reporting has developed NFPA 901, *Uniform Coding for Fire Protection*. This standard establishes basic definitions and terminology for use in fire reporting. Another standard, NFPA 902M, *Fire Reporting Field Incident Manual*, provides specific forms that can be used to document fires and other incidents, as well as instructions for completing those reports.

The 902F is a Basic Incident Report form used to document everything about the incident itself including location; the type, construction and use of the structure; how the fire started and spread; number of injuries and deaths; and information regarding fire department response and activities. This form is also used for nonfire incidents. (Figure 14.3 shows a copy of the NFPA 902F, Basic Incident Report.)

An additional form, the 902G, is a Basic Casualty Report used to document injuries and deaths in much greater detail. It is used both for civilians and fire fighters. It is designed to identify why and how the injuries and deaths occur, where victims were located, and what they were doing at the time of the injury or death. The form is also used to help identify the factors that contribute to fire fighter deaths and injuries, with particular emphasis on protective equipment failures.

Figure 14.1: CFIRS Basic Incident Report

SECTION A

CALIFORNIA FIRE INCIDENT REPORTING SYSTEM
INCIDENT REPORT (Manual Reporting)

1 FDID | INCIDENT NUMBER: Year, Exp. No.
2 CORRECTIONS Change ☐ Delete ☐ | ____________ **Fire Department** | MULTI-AGENCY INCIDENT NO.: Agency I.D., Year, Incident No.
3 INCIDENT DATE | DISPATCH TIME | ARRIVAL TIME | END TIME | ADD'L DAYS | FIRST IN COMPANY | DISTRICT
4 SITUATION(S) FOUND #1 #2 #3 #4 | AUTOMATIC OR MUTUAL AID | METHOD OF ALARM | TYPE WEATHER | AIR TEMPERATURE | PROPERTY MANAGEMENT
5 INCIDENT ADDRESS / LOCATION
6 ROOM / APARTMENT | ZIP CODE | CENSUS TRACT | FIRE HAZARD SEVERITY ZONE
7 TOTAL FIRE SERVICE PERSONNEL RESPONDED Career | Vol. | NO. APPARATUS RESPONDED Engine | Truck | Rescue Med. | Others
8 CODE | NAME: Last, First, M.I. | AREA | TELEPHONE
9 ADDRESS / CITY | STATE | ZIP
10 CODE | NAME: Last, First, M.I. | AREA | TELEPHONE
11 ADDRESS / CITY | STATE | ZIP
12 GENERAL PROPERTY USE | SPECIFIC PROPERTY USE | BUILDING CODE OCCUPANCY TYPE | STRUCTURE TYPE | STRUCTURE STATUS | OCCUPIED AT TIME OF INCIDENT
13 FOR MOBILE PROPERTY INVOLVED: Type | Vehicle License No. | State | Year | Make | Model | I.C.C. / D.O.T. Permit No. | Vehicle Identification No. | Drivers' License No. | State

SECTION B — COMPLETE FOR ALL FIRES

1 TYPE OF ACTION(S) TAKEN #1 #2 #3 #4 | FIRE ORIGIN Area | Level | Horizontal Distance From | FORM OF HEAT | IGNITION FACTOR
2 SEX | AGE | SEX | AGE | MATERIAL FIRST IGNITED Type | Form | CONTRIBUTING FACTOR(S) #1 #2 | METHOD OF EXTINGUISHMENT
3 ESTIMATED PROPERTY LOSS | ESTIMATED CONTENTS LOSS | FUEL MODEL | ACRES BURNED
4 IF EQUIPMENT INVOLVED IN IGNITION: Type | Model | Year | Make | Serial No.

SECTION C — COMPLETE FOR STRUCTURE FIRE

1 CONSTRUCTION TYPE | ROOF COVERING | NUMBER OF STORIES | EXTENT OF DAMAGE Flame | Smoke
2 MATERIAL GENERATING MOST SMOKE Type | Form | AVENUE OF SMOKE TRAVEL | DETECTION SYSTEM Type | Power Supply | Performance | Reason For Failure
3 EXTINGUISHING SYSTEM Type | Performance | Reason For Failure | SPRINKLER HEAD(S) Type | Number Activated

SECTION D — COMPLETE FOR FIRE SERVICE CASUALTY AND NON-FIRE SERVICE FIRE CASUALTY

1 FIRE SERVICE CASUALTY Injuries | Fatalities | NON-FIRE SERVICE FIRE CASUALTY Injuries | Fatalities

SECTION E — COMPLETE FOR E. M. S.

1 NUMBER OF PATIENTS | HIGHEST LEVEL OF CARE CAPABLE OF BEING PROVIDED ON SCENE Fire | Other | HIGHEST LEVEL OF CARE PROVIDED ON SCENE Fire | Other
2 E.M.S. TYPE OF SITUATIONS FOUND #1 #2 #3 #4 | NO. OF PATIENTS TRANSPORTED BY Fire Dept. | Non Fire Amb. | Coroner | Other

SECTION F — COMPLETE FOR HAZ MAT

1 OES CTRL. NUMBER | HAZ MAT RELEASE Area | Level | RELEASE FACTORS #1 #2 #3 #4 | CONTRIBUTING FACTOR(S) #1 #2
2 EST. NO. CHEMICALS RELEASED | TYPE OF EQUIPMENT INVOLVED IN RELEASE | #1 #2 #3 #4 | DISPOSITION OF INCIDENT
3 HAZ MAT I.D. SOURCES Personnel #1 #2 | Reference Material | Fatalities | NON-FIRE SERVICE HAZ MAT CASUALTY Injuries | Fatalities
4 CHEMICAL OR TRADE NAME | DOT HAZARD CLASS | CAS NO.
5 PHYSICAL STATE Stored | Released | QUANTITY RELEASED | EXTENT OF RELEASE | SUSPECTED ENVIRONMENTAL CONTAMINATION
6 CONTAINER Type | Material | Description Use | Feature | Capacity | UNIT OF MEASURE | ☐ ADDITIONAL HAZARDOUS MATERIALS ON BACK

USE CHMIRS FORM FOR REPORTING HAZ MAT INCIDENTS TO OES.

NOT REQUIRED

SECTION G — OTHER ACTION(S) TAKEN | SPECIAL STUDIES: Local | Statewide

TYPE OF ACTION(S) TAKEN #1 #2 #3 #4 | 1a b c d | 2a b c d | 3a b c d | 4a b c d | 5a b c d | 6a b c d

☐ COMMENTS ON BACK

MEMBER MAKING REPORT | DATE | REVIEWED BY

CFIRS 1 (REV. 2/93)

Figure 14.2: CFIRS Casualty Reports

SECTION A — CALIFORNIA FIRE INCIDENT REPORTING SYSTEM — **CFIRS 2**

FIRE SERVICE CASUALTY REPORT (Manual Reporting)

1	FDID		INCIDENT NUMBER Year		
2	CORRECTIONS Change ☐ Delete ☐	Fire Department	MULTI-AGENCY INCIDENT NO. Agency I. D. Year Incident No.		
3	INCIDENT ADDRESS / LOCATION				
4	ROOM / APARTMENT	ZIP CODE	COUNTY IF DIFFERENT	INCIDENT DATE	DISPATCH TIME

SECTION B

1	CASUALTY NUMBER	SEX	DATE OF BIRTH	AGE	SERVICE DATE
2	NAME: Last, First, M.I.			AREA	TELEPHONE
3	ADDRESS / CITY			STATE	ZIP
4	SOCIAL SECURITY NUMBER			EMPLOYEE Status	Assignment
5	CASUALTY DATE	CASUALTY TIME	SEVERITY / AFFILIATION	PRIMARY SYMPTOM	SECONDARY SYMPTOM
6	PART(S) OF BODY AFFECTED	ACTIVITY AT TIME OF CASUALTY		WHERE CASUALTY OCCURRED	
7	CAUSE OF CASUALTY	MEDICAL CARE PROVIDED		DISPOSITION OF CASUALTY	
8	CONTRIBUTING EQUIPMENT Used No. 1	Status No. 1		Performance No. 1	
9	CONTRIBUTING EQUIPMENT Used No. 2	Status No. 2		Performance No. 2	
10	CONTRIBUTING EQUIPMENTUsed No. 1 Used No. 3	Status No. 3		Performance No. 3	

CFIRS 2 (REV. 3/93)

SECTION A — CALIFORNIA FIRE INCIDENT REPORTING SYSTEM — **CFIRS 3**

NON-FIRE SERVICE CASUALTY REPORT (Manual Reporting)

1	FDID		INCIDENT NUMBER Year		
2	CORRECTIONS Change ☐ Delete ☐	Fire Department	MULTI-AGENCY INCIDENT NO. Agency I. D. Year Incident No.		
3	INCIDENT ADDRESS / LOCATION				
4	ROOM / APARTMENT	ZIP CODE	INCIDENT DATE	DISPATCH TIME	

SECTION B

1	CASUALTY NUMBER	SEX	DATE OF BIRTH	AGE	
2	CODE	NAME: Last, First, M.I.		AREA	TELEPHONE
3	ADDRESS / CITY			STATE	ZIP
4	CASUALTY DATE	CASUALTY TIME	SEVERITY	AFFILIATION	
5	FAMILIARITY WITH STRUCTURE	LOCATION OF CASUALTY AT TIME OF IGNITION	CONDITION BEFORE CASUALTY		
6	CONDITION PREVENTING ESCAPE	ACTIVITY AT TIME OF CASUALTY	CAUSE OF CASUALTY		
7	APPARENT SYMPTOM	PART(S) OF BODY AFFECTED	DISPOSITION OF CASUALTY		

CFIRS 3 (REV. 3/93)

☐ COMMENTS ON BACK — MEMBER MAKING REPORT — DATE — REVIEWED BY

Figure 14.3: NFPA 902F, Basic Incident Report

BASIC INCIDENT REPORT 902F

Fill In This Report In Your Own Words ________________ **Fire Department** ☐ Revised Report

A	FD ID	Incident No.	Index No.	Mo.	Day	Year	Alarm Time	Time on Scene	Time Last Unit Clear
B	Location/Address	City/Town	Zip Code	Property No.				
C	Occupant Name (Last, First, MI)	Telephone No.	Room or Apt.					
D	Owner Name (Last, First, MI)	Address	Telephone No.					
E	Method of Alarm to Fire Department	Type of Incident						
F	Type of Action Taken	District	Shift	No. Alarms	Mutual Aid ☐ Rec'd ☐ Given ☐ N/A			
G	General Property Use	Specific Property Use	County	Census Tract				
H	No. Injuries* Fire Service / Other Emerg. / Civilian	No. Fatalities* Fire Service / Other Emerg. / Civilian						
I	No. Fire Service Personnel Responded	No. Engines Responded	No. Aerial Apparatus Responded	No. Other Vehicles Responded				
J	Condition of Fire upon Arrival of First Unit	Time from Alarm to Agent Application	Area of Fire Origin					
K	Equipment Involved in Ignition	Year	Make	Model	Serial No.			
L	Form of Heat of Ignition	Material First Ignited Form/Use	Type					
M	Ignition Factor	Method of Extinguishment						
N	Property Damage Classification	No. Buildings Damaged	Termination Stage					
O	Construction Type	No. of Stories	Level of Origin					
P	Structure Status	No. of Occupants at Time of Incident						
Q	Material Generating Most Flame Form/Use	Type	Factor Contributing to Flame Travel					
R	Material Generating Most Smoke Form/Use	Type	Avenue of Smoke Travel					
S	Detector Type	Detector Power Supply	Detector Performance					
T	Sprinkler System Performance	No. of Sprinkler Heads Operated						
U	Extent of Flame Damage	Extent of Smoke Damage	Extent of Extinguishing Agent Damage					
V	Mobile Property Type	Year	Make	Model	Serial No.	License No.		
W	No. of Private Acres Burned	No. of Federal Acres Burned	No. of Other Public Acres Burned					
X	Member Making Report	Date	Officer in Charge (Name, Position, Assignment)	Date				
Y	Remarks:							

☐ Remarks continued on reverse side.

Side labels: COMPLETE ON ALL INCIDENTS (rows A–I); ON ALL FIRES TI 10-19 (rows J–N); FOR STRUCTURE FIRE TI 11-13 (rows O–U); TI 12-14 (row V); TI 15 (row W); COMPLETE IF FIRE TYPE OF INCIDENT (TI) 10-19 (rows J–W); COMPLETE ON ALL INCIDENTS (rows X–Y).

*A Form 902G must be completed for each Fire Casualty.

This form is for use with NFPA 902M, *Field Incident Manual*. Users should also refer to NFPA 901, *Uniform Coding for Fire Protection*, for information on fire reporting systems and classifications for information entered on this form.

Benefits of a Fire Reporting System

There are a number of benefits the a fire department can derive from a good incident reporting system. These include:

- ❑ Identifying the fire problem (on a community, state or federal level). Statistics can show a variety of things including cause of ignition; contributing factors; type, age and condition of fire victims; type of property involved; and dollar loss.
- ❑ Identifying the causes of deaths and injuries on the fireground to both civilians and fire fighters.
- ❑ Supporting budget requests. Good statistics may help save programs that are in danger of being cut and help justify funding for new programs.
- ❑ Identifying the need for new or more stringent fire codes, or for better code enforcement programs.
- ❑ Determining the need for new public education programs, and evaluating the success of existing programs.
- ❑ Improving the allocation of existing resources and/or planning for future growth.
- ❑ Scheduling nonemergency activities, such as training and inspections, at times when they least likely to be interrupted by emergencies or to impact response times to emergency calls.
- ❑ Identifying safety problems associated with various types of consumer products, and regulating product safety as needed.
- ❑ Evaluating fire protection designs and systems, ranging from building construction features to automatic fire protection and alarm systems.

Ten Major Findings on the Nature of the U.S. Fire Problem

The 17th edition of the NFPA Fire Protection Handbook lists ten major U.S. Data Based Findings of the last decade (1980 - 1989). The list is not arranged in any order of priority. Nor does it necessarily reflect what every department or every state would consider its ten most important findings. However, it does show how databases and the analysis of that information can be used to identify problems and help design appropriate fire protection programs.

- ❑ Home smoke detectors can cut the risk of dying in a fire in half. By the late 1980s, five out of every six homes in the United States had at least one smoke detector. However, it has also been shown that one third of the detectors were not operational, primarily because of dead or missing batteries.
- ❑ Automatic sprinklers are very effective in reducing loss of life and property in fire emergencies.
- ❑ Heating equipment such as wood stoves, portable kerosene heaters and gas-fueled space heaters have caused a sharp increase in the amount of fires and fire deaths since the late 1970s. In fact, 30% of home fires begin with heating equipment, as do more than 16% of home fire deaths.

- ❑ The number of reported incendiary and suspicious fires dropped by nearly 40% from 1977 to 1988. However, associated civilian deaths have increased by 17%. Associated property damage, adjusted for inflation, has been essentially constant since 1983.
- ❑ A large percentage of fire fighter fatalities are attributed to stress-related heart attacks and activities away from the fireground. More than one fourth of all fire service deaths in 1988 occurred while responding to or returning from a call. These statistics emphasize the value of physical fitness and vehicle safety programs.
- ❑ Rural areas have the highest fire death rates: more than double the rate in small cities, and more than 50% higher than the death rate in the largest cities.
- ❑ The largest percentage of residential fire deaths is due to smoking materials igniting upholstered furniture, mattresses or bedding. Smoking accounted for nearly 30% of all residential fire deaths where the cause of fire was known. Out of those smoking-related fire deaths, 75% involved ignition of upholstered furniture, mattresses, or bedding.
- ❑ U.S. and Canadian fire death rates are the highest of all developed countries in the free world; they are at least double the rates in Japan and Western Europe.
- ❑ The states of the Old South have the highest fire death rates. The major factors are heating equipment, poverty, and poor education.
- ❑ Older adults are more vulnerable to fire because of their limited mobility. The risk of dying in a fire increases significantly as people get older.

Statistics

Figures 14.4-14.12 contain some of the statistics reported in the 17th edition of the NFPA Fire Protection Handbook. Sources for this information include both NFPA and NFIRS surveys. Figures 14.13-14.16 contain California statistics provided by the State Fire Marshal's office. The source for this information is CFIRS. (Additional statistics regarding fire fighter deaths and injuries can be found in Chapter 17 on Fireground Safety.)

(Note: This chapter includes some pie graphs starting on page 14.10. The first wedge in the pie starts at the 12:00 position and moves clockwise. The corresponding key starts at the bottom and works up.)

Figure 14.4: U.S. Fire Incidents (1980-1988)

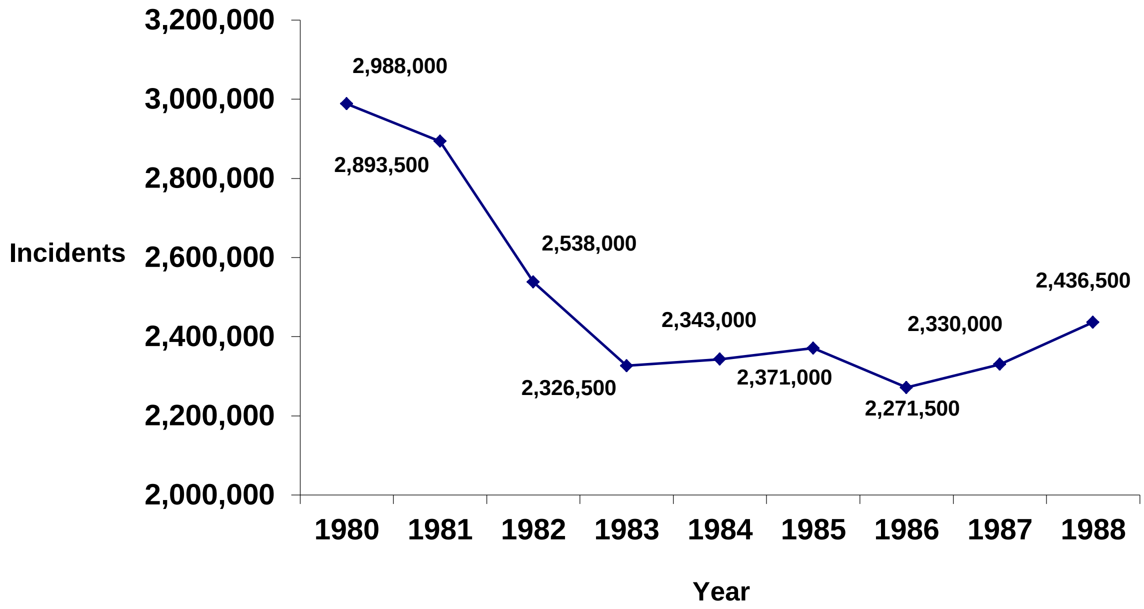
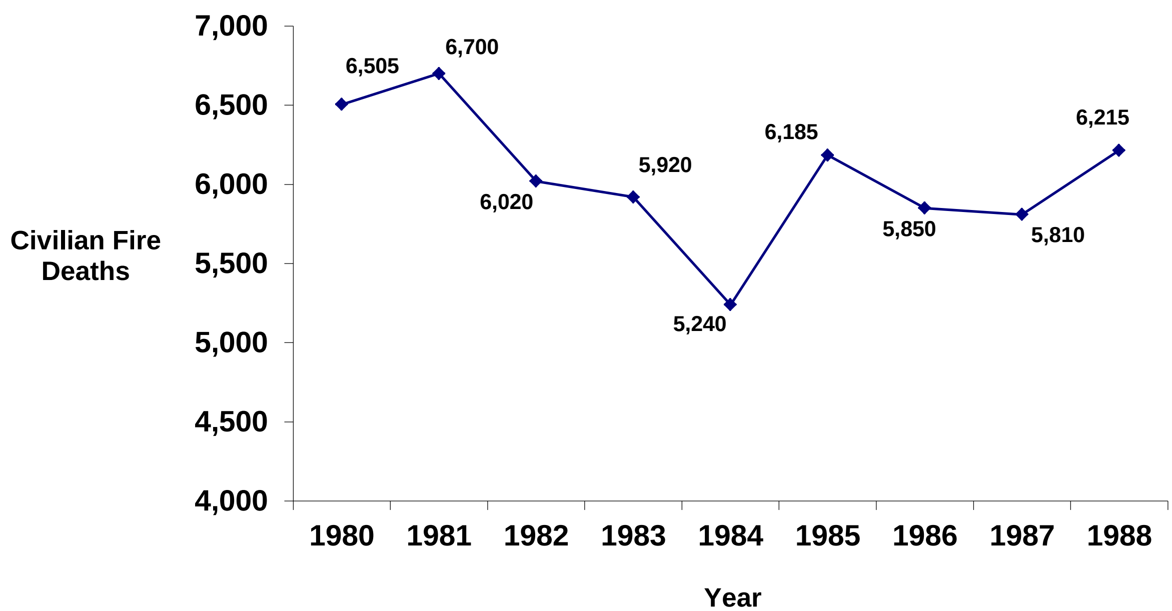


Figure 14.5: U.S. Civilian Fire Deaths (1980-1988)



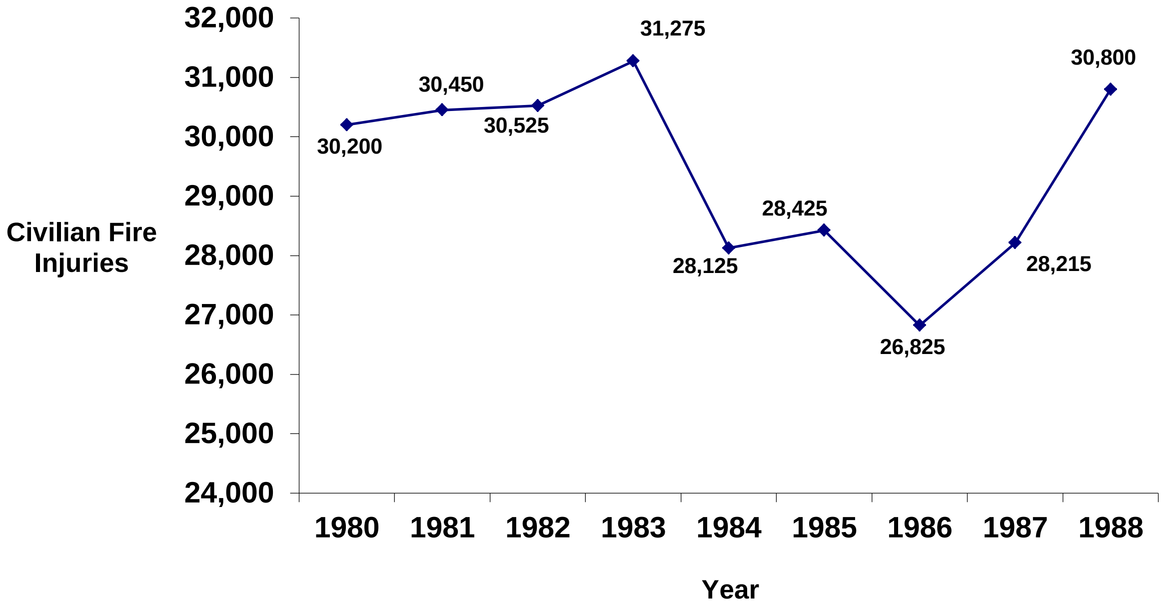
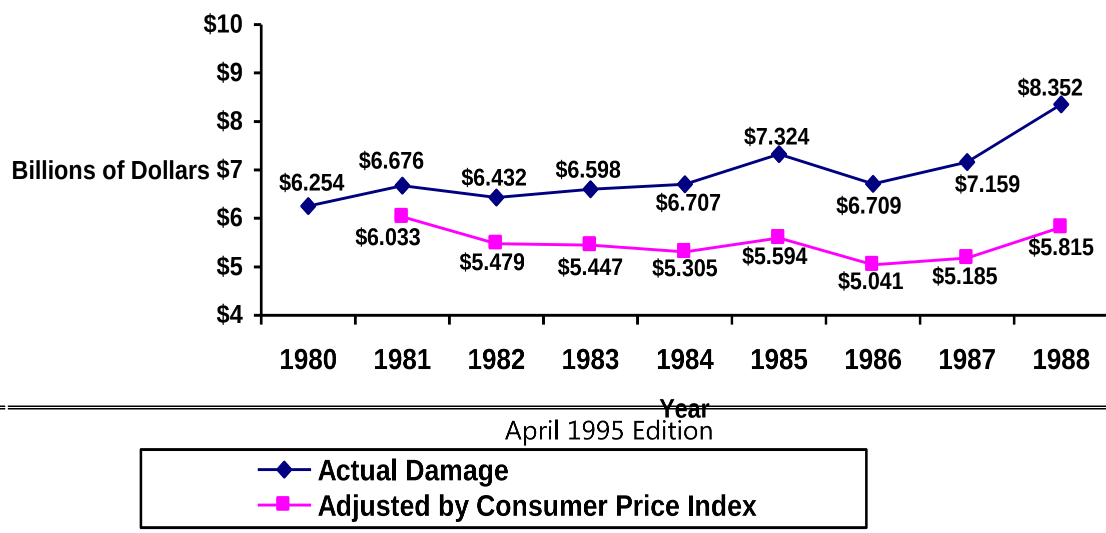


Figure 14.6: US Civilian Fire Injuries (1980-1988)

Figure 14.7: U.S. Direct Property Fire Damage (1980-1988)



In Figures 14.8 - 14.11, the category of "Mobile Environment" includes vehicles of all kinds. "American Community" includes all public assembly properties; educational, health care, or correctional facilities; stores; and offices. It also includes residential properties that do not qualify as homes, such as hotels and motels, rooming and boarding houses, dormitories, fraternity or sorority houses, and barracks. "Other Structures" includes all buildings that are vacant or under construction, demolition, or renovation. It also includes bridges, tunnels, and other structures that are not buildings.

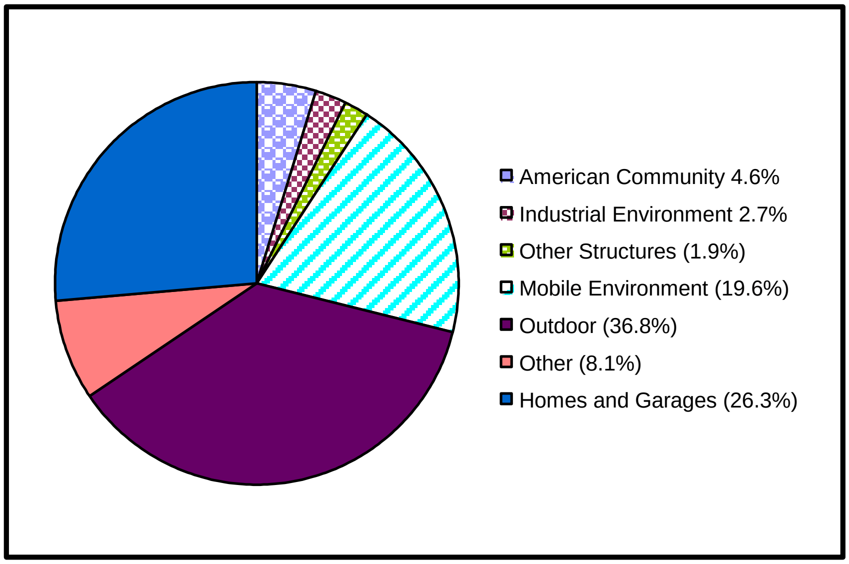


Figure 14.8: Reported Fire Incidents by Major Property Class (1983-1987)

Figure 14.9: Civilian Fire Deaths by Property Use (1983-1987)

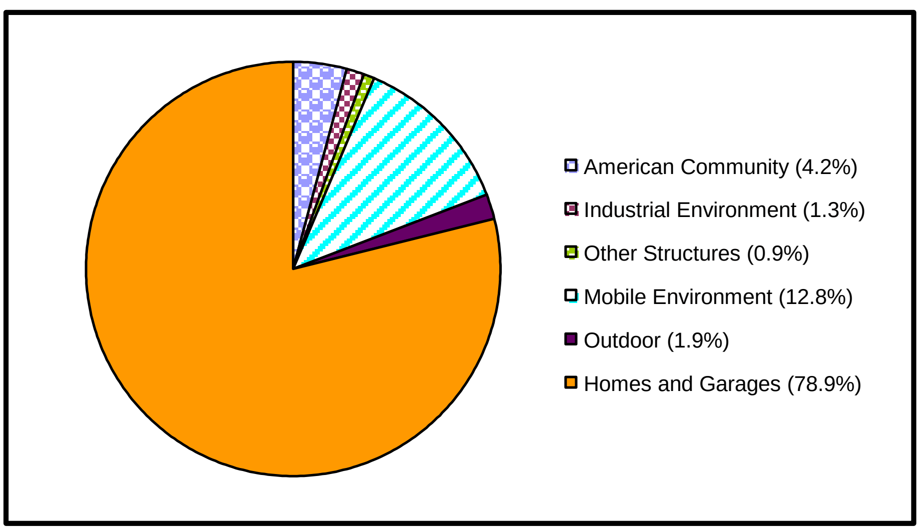


Figure 14.10: Civilian Fire Injuries by Property Use (1983-1987)

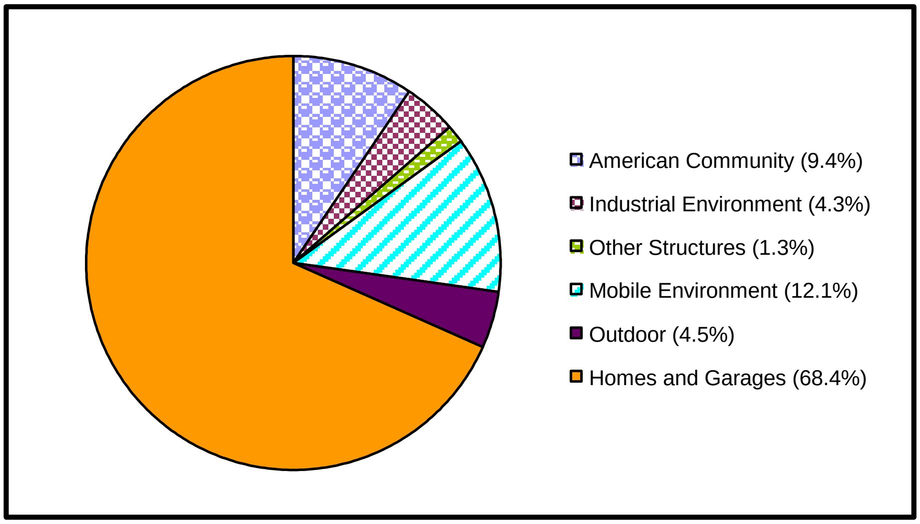


Figure 14.11: Direct Property Damage by Major Property Use (1983-1987)

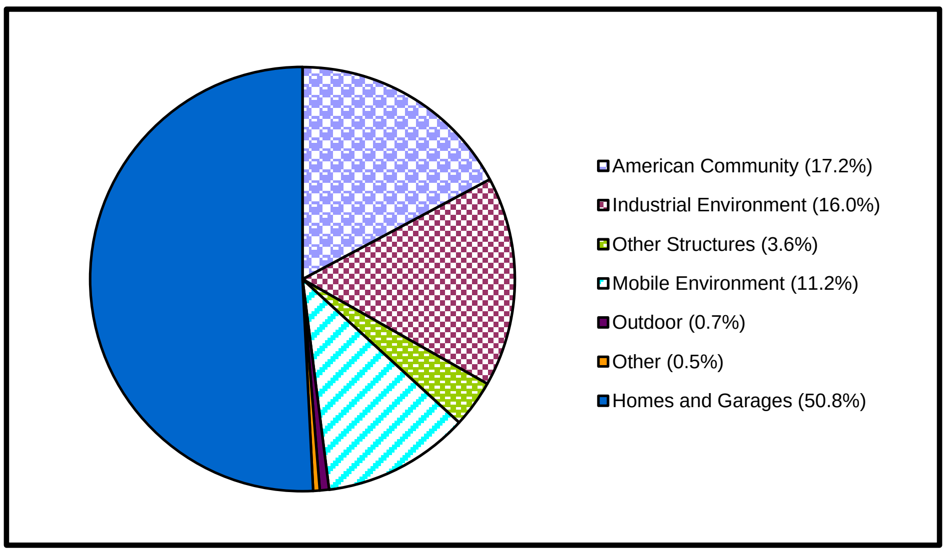


Figure 14.12: Major Causes of Reported U.S. Structure Fires (1983 - 1987 Annual Average)

Cause	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)	Fires
Defined by Heat Source				
Smoking material (lighted tobacco)	1,560	3,830	$384	64,300
Heating equipment	820	3,110	$832	191,700
Electrical distribution	450	1,780	$841	76,600
Cooking equipment	400	5,000	$389	132,1000
Defined by First Ignited Item				
Upholstered furniture	1,070	2,450	$249	27,300
Mattress or bedding	800	3,500	$288	52,700
Combustible or flammable liquid or gas	640	5,110	$821	73,100
Structural member or framing	370	1,030	$984	68,200
Wall covering	330	870	$409	32,800
Defined by Behavior				
Arson or suspected arson	760	2,850	$1,747	137,600
Child fire play	390	2,190	$201	37,500

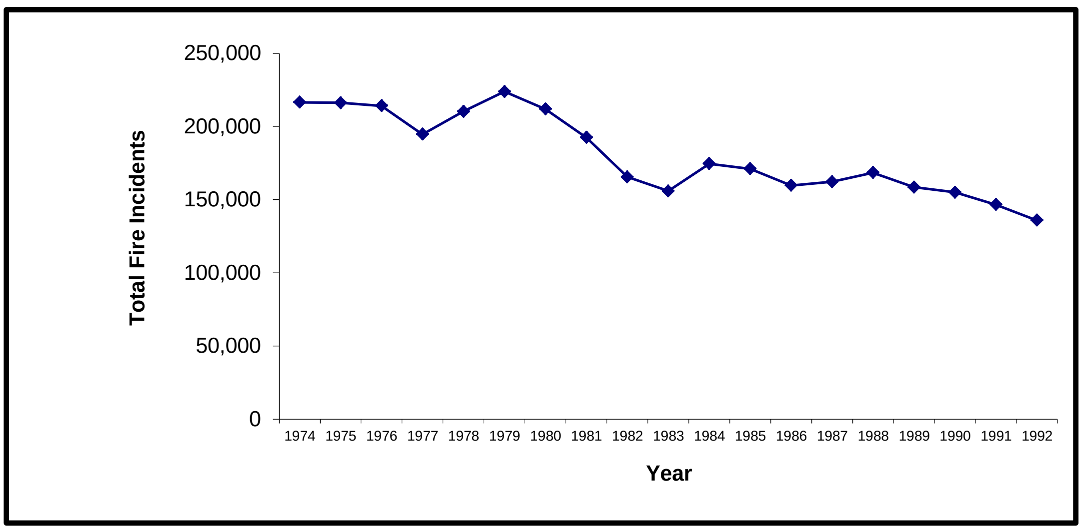
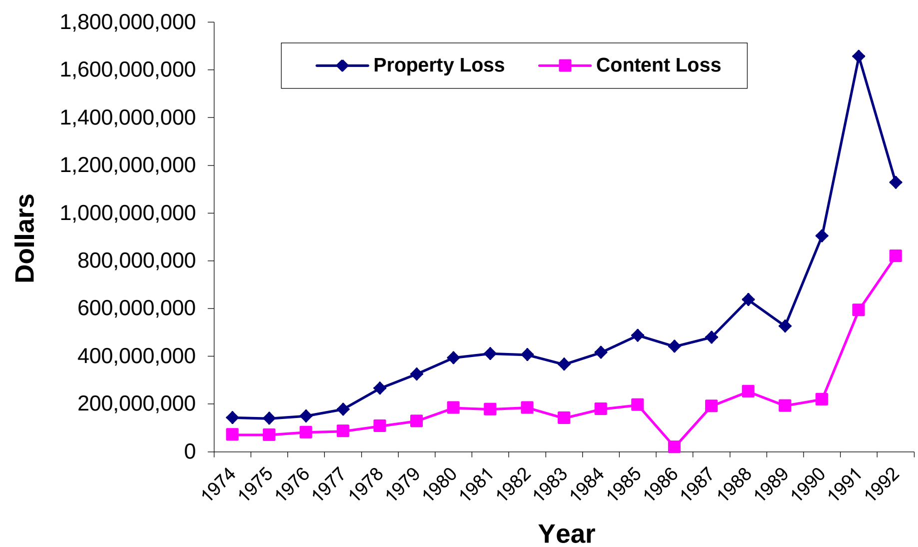


Figure 14.13: Total Fire Incidents in California

Year	Fire Incidents	Year	Fire Incidents	Year	Fire Incidents	Year	Fire Incidents
1974	216,528	**1979**	223,818	**1984**	174,612	**1989**	158,470
1975	216,175	**1980**	211,934	**1985**	171,131	**1990**	154,970
1976	214,088	**1981**	192,460	**1986**	159,700	**1991**	146,655
1977	194,620	**1982**	165,471	**1987**	162,203	**1992**	135,861
1978	210,335	**1983**	155,892	**1988**	168,492		

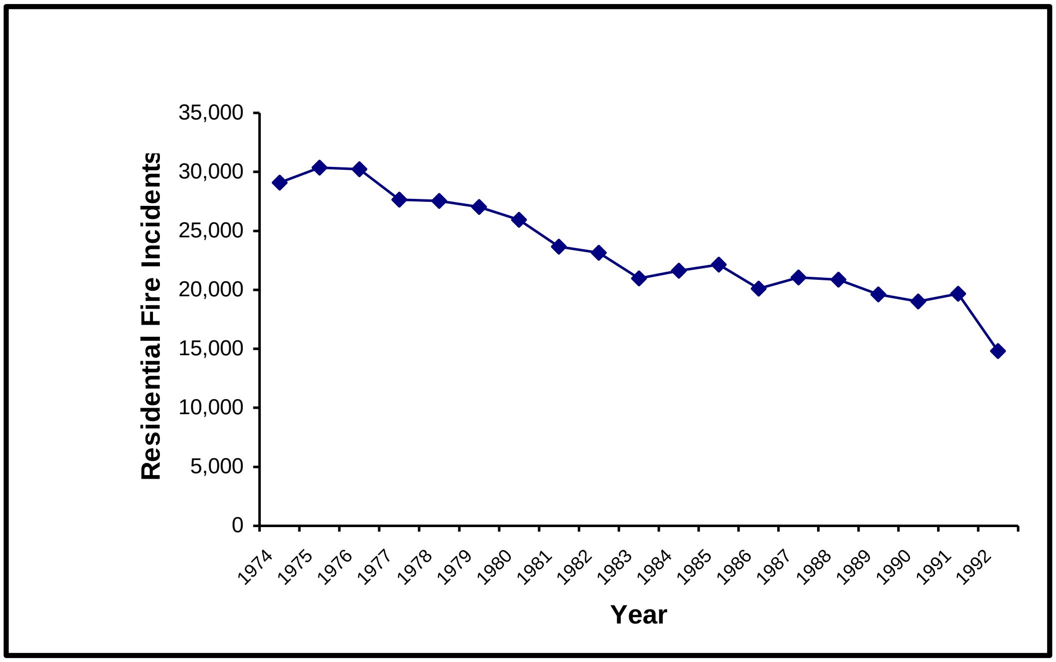
Figure: 14.14: Total Property and Content Loss in California



Dollar loss estimated by fire department (not all fire incident reports contain a dollar loss).

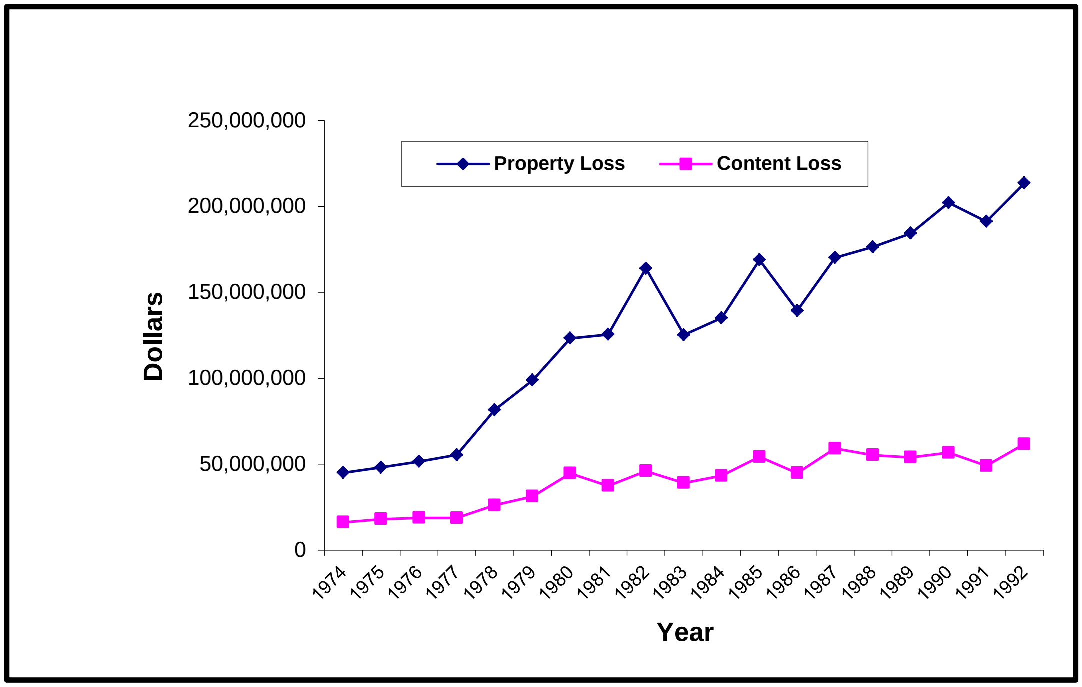
Year	Property Loss	Content Loss	Year	Property Loss	Content Loss
1974	142,235,410	70,816,237	**1984**	415,654,433	177,879,898
1975	139,027,705	70,114,383	**1985**	486,832,168	195,515,491
1976	148,925,083	80,644,983	**1986**	440,694,122	183,965,305
1977	177,212,993	85,551,287	**1987**	478,763,535	190,527,844
1978	265,387,620	107,055,772	**1988**	636,791,246	251,632,217
1979	325,033,995	127,825,420	**1989**	526,159,590	192,321,012
1980	393,263,683	183,452,219	**1990**	903,968,308	218,962,508
1981	410,712,516	177,387,223	**1991**	1,655,746,765	593,186,255
1982	405,956,740	184,050,875	**1992**	1,127,775,714	819,217,167
1983	365,841,636	140,403,503			

Figure 14.15: Residential Fire Incidents in California



Year	Fire Incidents	Year	Fire Incidents	Year	Fire Incidents	Year	Fire Incidents
1974	29,077	**1979**	27,024	**1984**	21,615	**1989**	19,612
1975	30,356	**1980**	25,946	**1985**	22,143	**1990**	19,029
1976	30,222	**1981**	23,649	**1986**	20,110	**1991**	19,684
1977	27,653	**1982**	23,148	**1987**	21,061	**1992**	14,816
1978	27,534	**1983**	20,968	**1988**	20,869		

Figure 14.16: Residential Fire Loss in California



Dollar loss estimated by fire department (not all fire incident reports contain a dollar loss).

Year	Property Loss	Content Loss	Year	Property Loss	Content Loss
1974	45,015,535	16,192,772	**1984**	135,042,699	43,259,254
1975	48,072,727	18,003,036	**1985**	168,830,238	54,247,557
1976	51,559,586	18,747,512	**1986**	139,328,696	44,824,904
1977	55,327,369	18,685,337	**1987**	170,127,776	59,072,068
1978	81,647,293	26,150,063	**1988**	176,427,362	55,236,419
1979	98,801,341	31,210,713	**1989**	184,345,818	53,956,354
1980	123,236,060	44,691,955	**1990**	202,055,936	56,643,722
1981	125,432,865	37,431,395	**1991**	191,167,842	49,012,288
1982	163,968,010	45,824,918	**1992**	213,514,636	61,655,908
1983	125,219,611	39,057,108			

Summary

Documentation provides a legal record of incidents, keeps upper management informed of activities within the department, and provides a means to develop a database of information. This data base can be used for many purposes including identifying the fire problem within the community, identifying the cause of deaths and injuries in order to implement more effective safety and public education programs, developing and evaluating fire codes, and supporting budget requests. Every company officer has a responsibility to accurately document incidents and to understand how this information is used.

Chapter Review Questions

1. What are three basic reasons for documenting incidents?

    ____

    ____

2. What are NFIRS and CFIRS?

    ____

    ____

3. What information is documented on the NFIRS and CFIRS forms?

    ____

    ____

4. List some of the benefits of a fire reporting system.

    ____

    ____

5. What are some of the major findings on the nature of the U.S. Fire Problem (as documented in the 17th Edition of the NFPA Fire Protection Handbook)?

    ____

    ____

    ____

Topic 15: Local Resources

There are numerous local resources that a fire officer can draw upon during an emergency. These resources begin within the fire department, but may also include other public agencies and private entities. Pertinent data concerning these resources must be identified prior to an emergency so that they may be summoned promptly when needed.

Fire Department Resources

First and foremost, the fire officer must be familiar with the resources available within the department. He or she must know what to expect from responding personnel and apparatus. How many people are assigned to the first and second due units? This is pretty standard within a paid department, but it may vary greatly in a volunteer department. What kind of apparatus will respond on the first alarm, and what will be their capabilities and limitations? What is the capacity of the pump? How much water is contained in the tank? Will there be an aerial with an elevated water tower? Is off-road capability available if needed?

What equipment is coming with those units? Do they carry large diameter hose or master stream appliances? Do they have power tools and other special equipment that might be required?

Is the water system adequate to fight this fire? Or, will it be necessary to request water tenders? What is the location of cisterns, elevated tanks, drafting sites, or other supplemental water supplies? Do the responding apparatus have the capability to draft or to hook up to some of the connections they might find in remote locations?

What resources will be available if the incident escalates beyond the first alarm assignment? The Incident Commander must be familiar with the number of personnel and apparatus, and the type of apparatus that will respond on additional alarms. How long will it take for senior officers to arrive? What kind of automatic and mutual aid agreements exist with surrounding communities? How is it initiated? What are the response times? What type of protocols exit for working together on the fireground? Will their SOPs work with your companies? How about local emergency plans? Does one exist? If so, how is it activated and what responsibilities do individual fire officers have within the plan?

Specific details of fireground management will be covered in later chapters. However, it is important that fire officers realize that existing rules, regulations and management systems (such as ICS) also become a resource for they give the fire officer some guidance in handling the incident.

Public Agencies

There are many agencies available within local government that may be called upon as resources depending on the emergency. Perhaps the most common agency that will assist the fire department is law enforcement. They are often needed for traffic and crowd control, but may also be used to maintain security of the scene or evacuate people who may be at risk from fire, smoke or hazardous materials.

Other agencies that may be needed include the water department, public works and/or the street department, and the Red Cross or Salvation Army. Certainly there can be many more in each jurisdiction. The fire officer must be familiar with the particular resources available in his or her community, as well as how to access them, their general capabilities and their response times.

Private Entities

Resources are not limited to public agencies. Private entities such as utility and power companies, towing services, salvage and sanitation services, and hazardous waste haulers are among the special services that are sometimes needed. It may be necessary to request special heavy equipment and trained operators. Once again, the fire officer must be familiar with these various resources, as well as who has authority to summon them. Some of these private entities will require a purchase order promising payment before they respond.

Summary

It can be a very lonely feeling when everything that could go wrong is going wrong and you are the one in charge. But, there are many resources available to the fire officer. He or she must be familiar with the resources within the department, as well as public agencies and private entities that are available to help. Getting these resources on-scene early can make the whole operation a lot smoother.

Chapter Review Questions

1. What are some of the things that the fire officer should know about the resources within his or her fire department?

   ____

   ____

   ____

2. What "logistical factors" should the fire officer know when summoning resources from other public agencies or private entities?

   ____

   ____

   ____

Activity 15-1

TITLE:	Available Resources
DIRECTIONS:	1. List some of the resources that your department can call upon, and the functions they might serve

Level	Resource		Function
Fire Department			
Public Agencies			
Private Agencies			

Topic 16: State and Federal Resources

Less widely known are some of the resources available within state and federal government. Information on these agencies may be kept at the department communications center or within Emergency Action Plans. However, fire officers must be at least familiar enough with them to know what resources are available, the assistance they can provide, and how to access them.

State and Federal Agencies

A number of agencies exist at the state and federal levels. Federal agency assistance is normally requested through a state or regional emergency plan. Agencies that fire departments work with most often include:

State Fire Marshal's Office (OSFM)

The State Fire Marshal's Office is the primary authority on fire protection in the state.

U.S. Forest Service (USFS)

The U.S. Forest Service provides fire protection to more than 200 million acres of forests, grasslands, and nearby private lands (National Forest System); conducts research and develops improved methods in forest fire management; and provides technical and financial assistance to state forestry organizations to improve fire protection efficiency on nonfederal wildland.

California Department of Forestry (CDF)

The California Department of Forestry provides fire protection and rescue services to areas of state responsibility.

California Highway Patrol/State Police (CHP)

These agencies enforce the laws related to the highways and byways of the state. They also have responsibility for Incident Command at hazardous materials incidents on public roads.

Office of Emergency Services (OES)

The Office of Emergency Services is responsible to provide for the state's needs in preparing for and handling major emergencies.

Environmental Protection Agency (EPA)

The Environmental Protection Agency has responsibility for numerous programs that greatly impact the storage of hazardous materials and mitigation of hazardous materials releases.

Department of Transportation (DOT)

The Department of Transportation is concerned with safety in all modes of transportation. There are ten major operational units within the DOT. They are the U.S. Coast Guard (USCG), the Federal Aviation Administration (FAA), the Federal Highway Administration, the Federal Railroad Administration, the National Highway Traffic Safety Administration, the Maritime Administration, the

Urban Mass Transportation Administration, the Materials Transportation Board (MTB), the Transportation Safety Institute, and the Transportation Systems Center.

Some of the other agencies a department might work with, depending on the type and magnitude of the incident, include the Bureau of Land Management, the National Park Service, the Bureau of Indian Affairs, National Disaster Offices, and the Military (Navy, Air Force, Army, Marines, and National Guard).

Summary

It is beyond the scope of this class to go into detail on all the various state and federal agencies that are available for assistance. However, the Incident Commander must keep in mind that they can be a valuable resource, particularly with large or complex incidents. Information on these agencies, as well as how to access them, must be kept in a convenient location within the department or the communications center so that these resources can be used in an emergency.

Chapter Review Questions

1. Identify how each of the agencies listed below can be of assistance to your department.

State Fire Marshal's Office ______________________________

U.S. Forest Service ______________________________

California Department of Forestry ______________________________

Highway Patrol/State Police ______________________________

Office of Emergency Services ______________________________

Environmental Protection Agency ______________________________

Department of Transportation ______________________________

Topic 17: Fireground Safety

Fire fighting is one of the most hazardous occupations in the country. Fire fighters are often working in environments that are hostile, unstable, toxic, or otherwise dangerous. The job frequently puts extreme physical demands on the body. Fire officers must be aware of the activities and conditions that result in fire fighter deaths and injuries, and must take appropriate measures to protect themselves and their crews at all times while on duty.

Statistics

Over 100 fire fighters are killed in the line of duty each year; over 100,000 are injured. The tables and graphs in this section provide a statistical breakdown of how and where these deaths and injuries occur. (Source: NFPA Fire Protection Handbook, 17th edition.)

Figure 17.1: Line of Duty Fire Fighter Deaths (1978-1989)

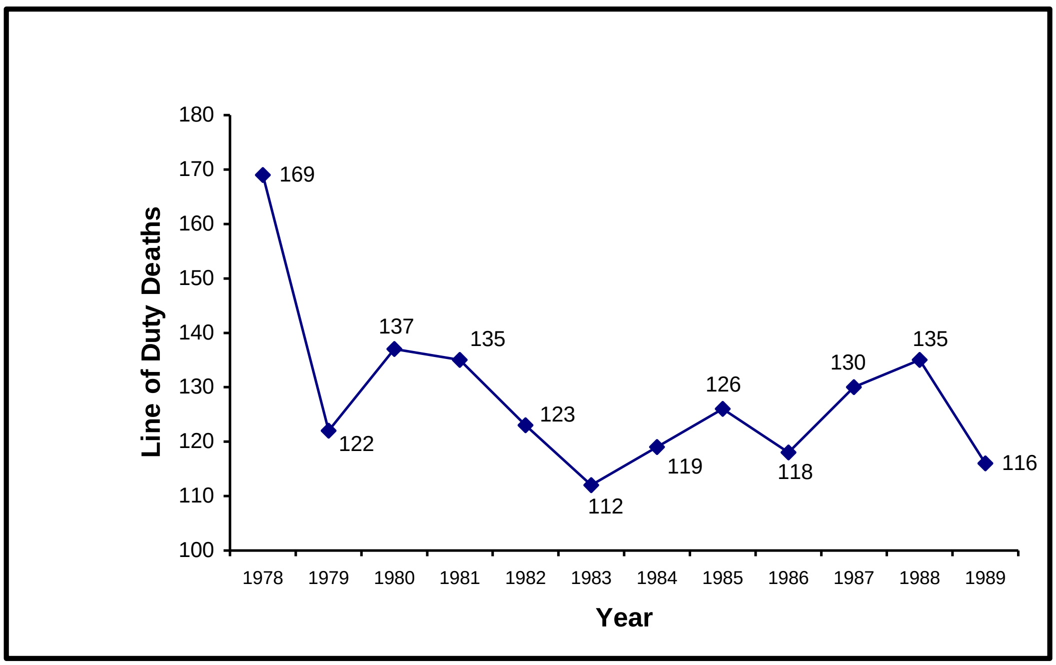


Figure 17.2: Fire Fighter Deaths by Type of Duty (1989)

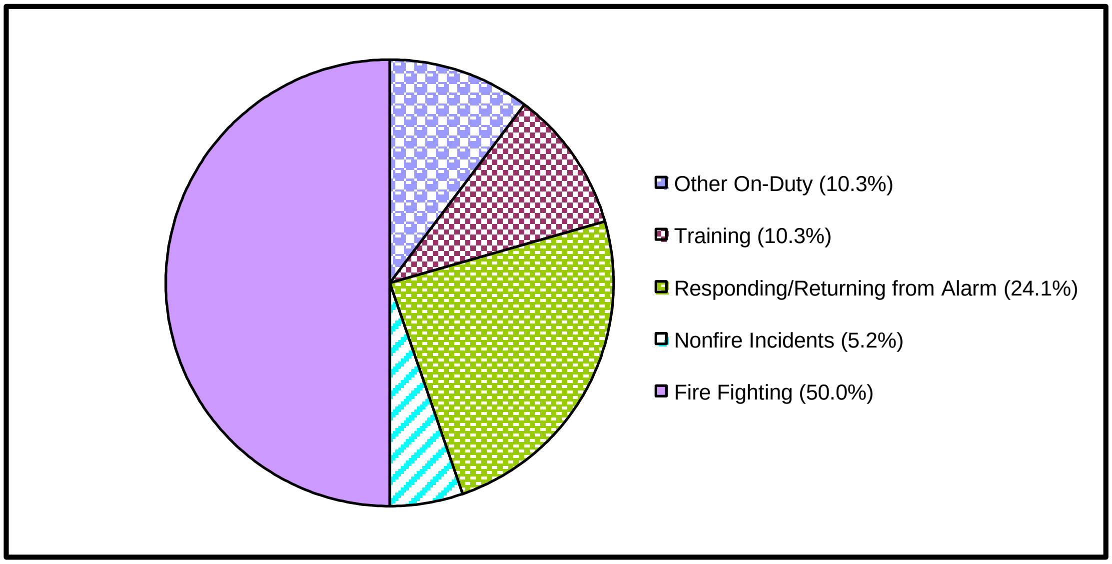


Figure 17.3: Fire Fighter Deaths by Cause of Fatal Injury (1989)

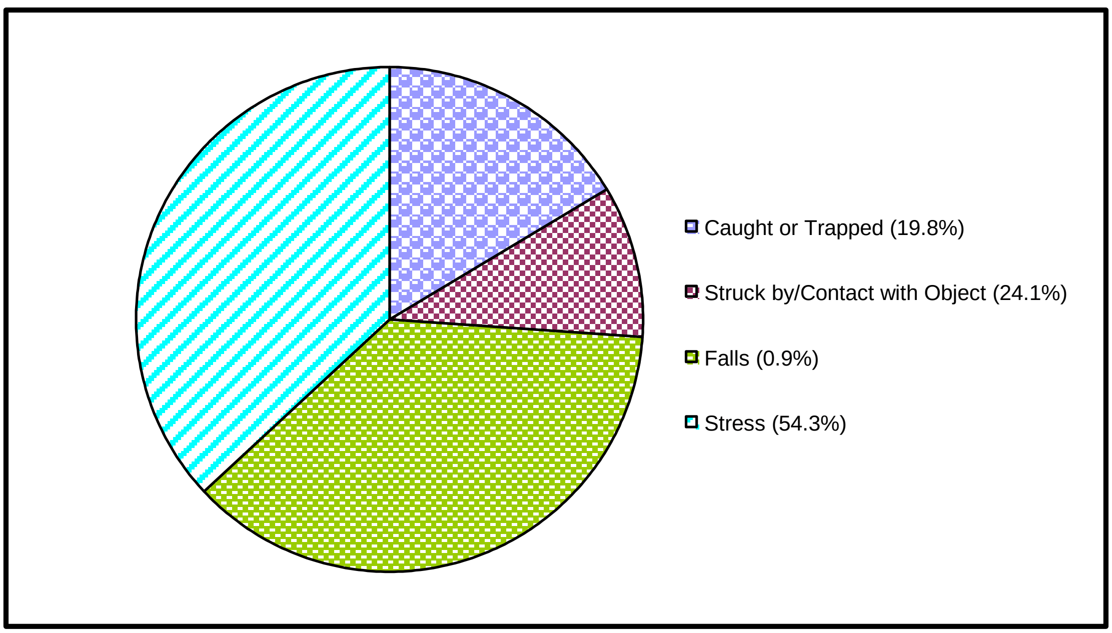


Figure 17.4: Fire Fighter Deaths by Nature of Fatal Injury (1989)

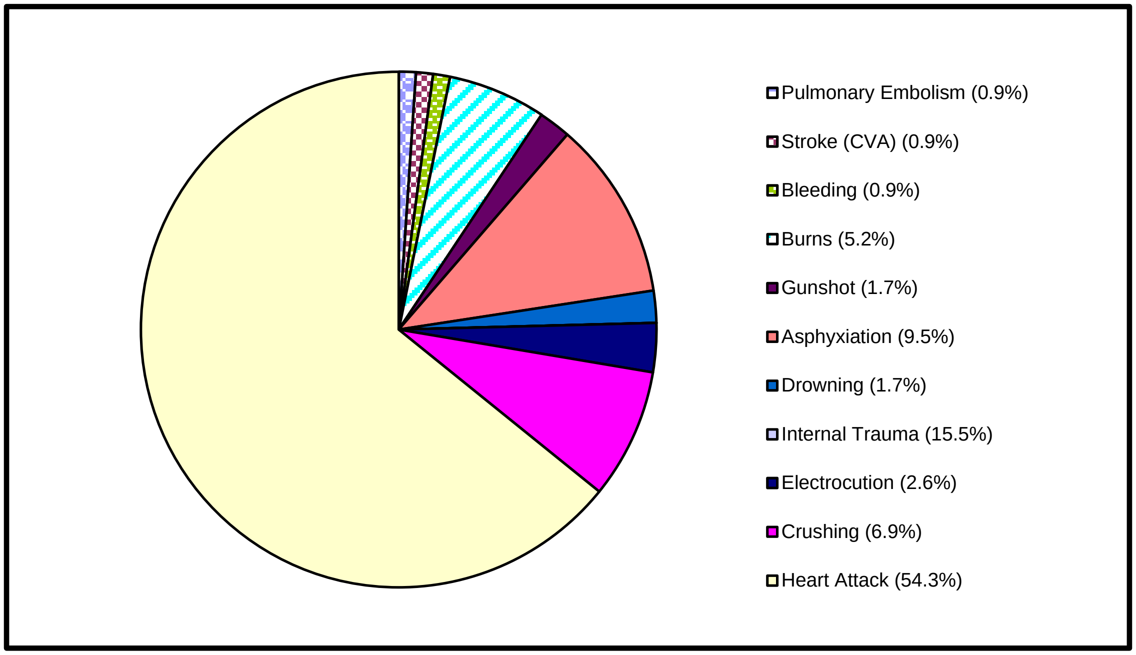


Figure 17.5: Fireground Deaths by Fixed Property Use (1989)

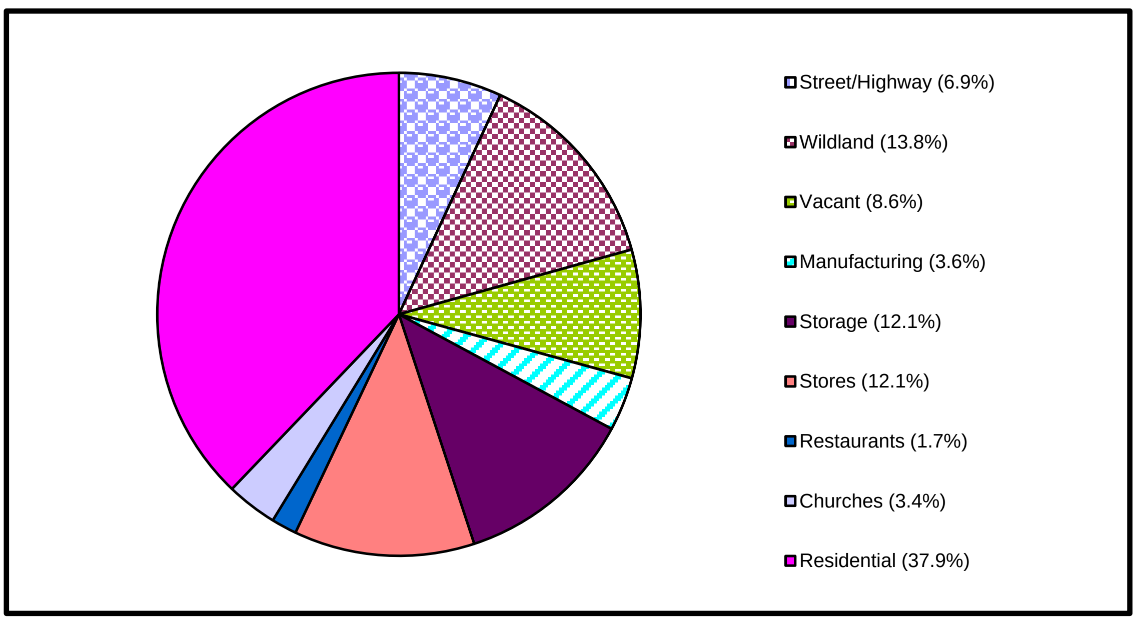


Figure 17.6: Line of Duty Fire Fighter Injuries (1983-1989)

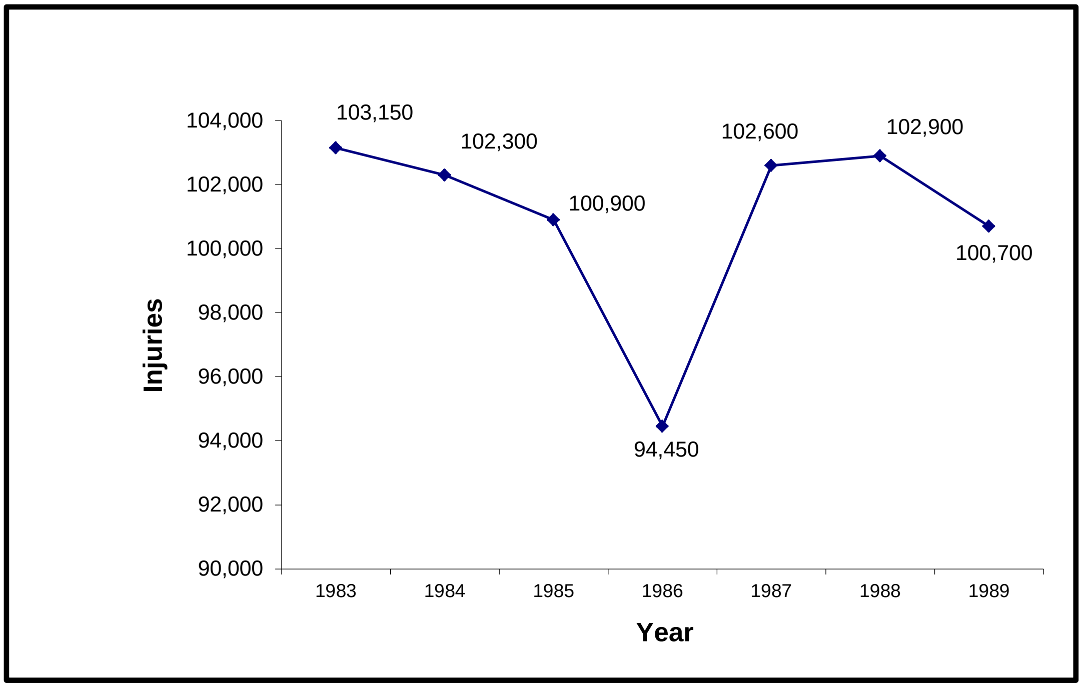


Figure 17.7: Fire Fighter Injuries by Type of Duty (1989)

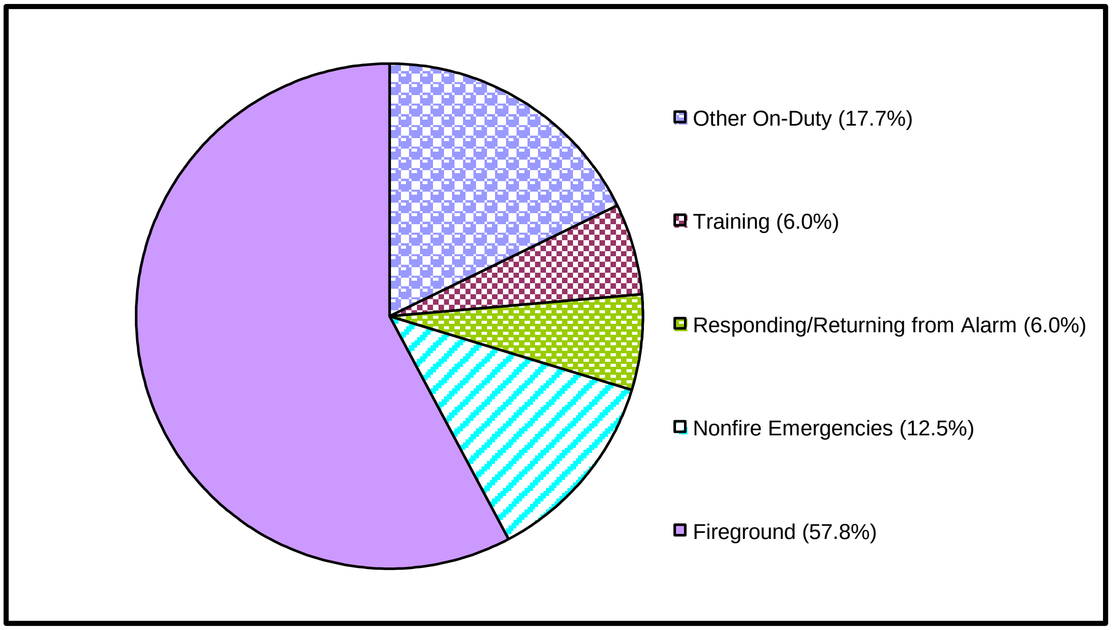


Figure 17.8: Fire Fighter Injuries by Cause (1989)

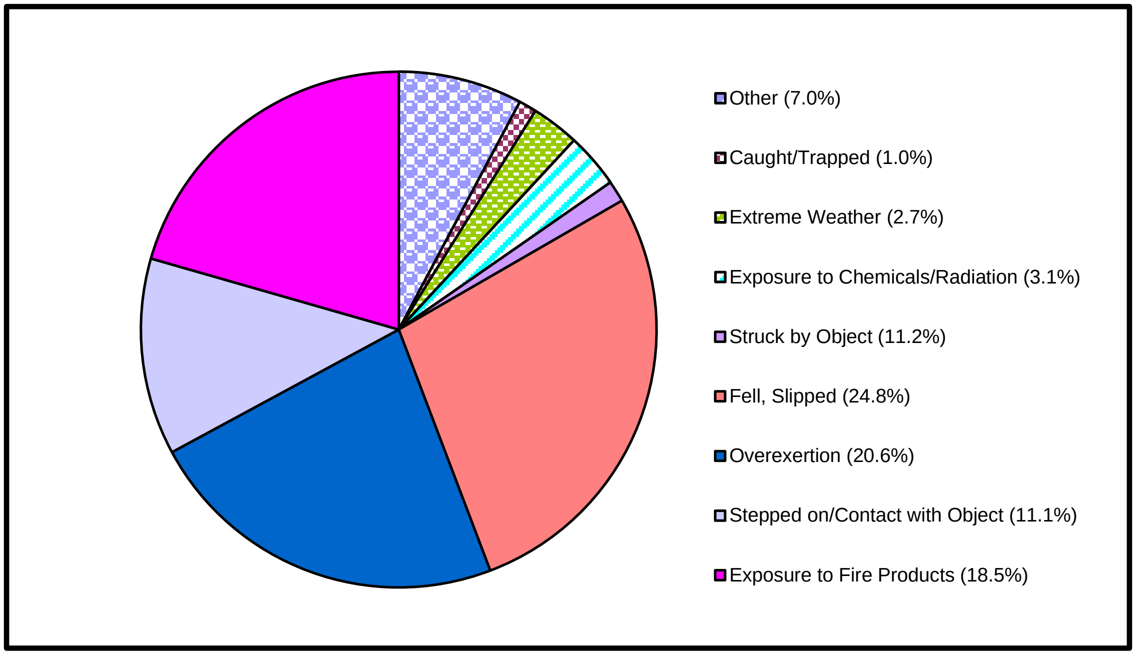
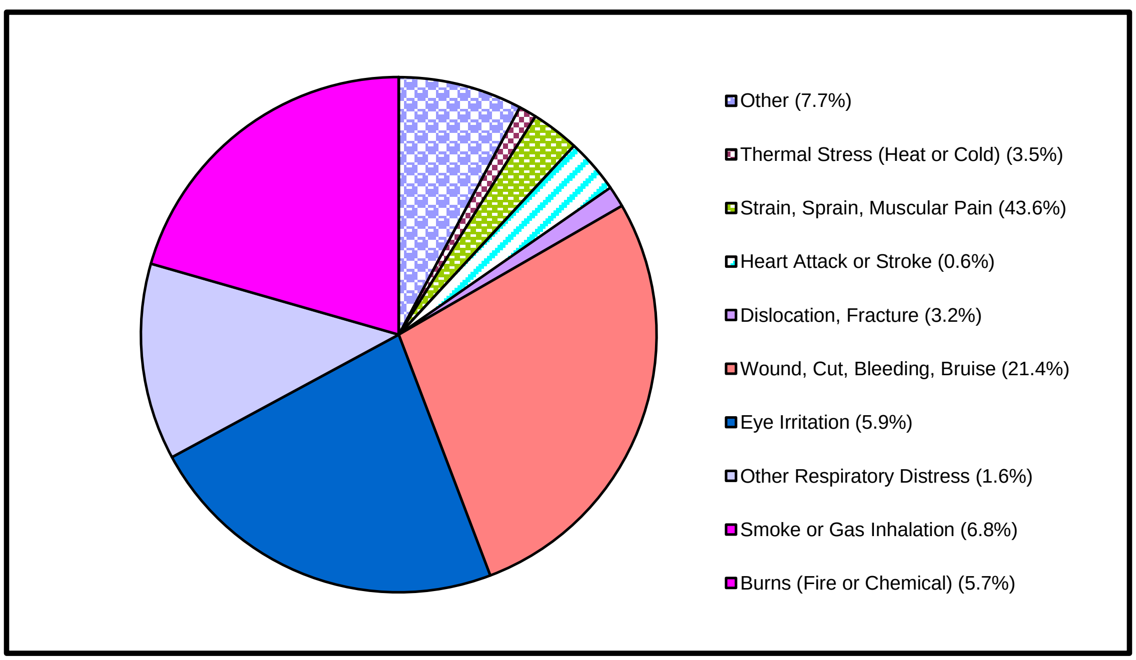


Figure 17.9: Fire Fighter Injuries by Nature of Injury (1989)



Areas of Emphasis for Fire Fighter Safety

Fire fighting is a dangerous occupation. There is no way to avoid that. However, most deaths and injuries can be prevented through conscientious commitment to department safety programs.

Management Support

Management support is essential in order for any program to be successful. Management must be proactive in promoting safety for all personnel. That is true for all managers from the individual company officer on up to the chief of the department. Management must also be open to input from the fire fighters on the line. The fire fighters are the ones doing the job. Often they have the best insight as to where the hazards are and how to best prevent injuries from those hazards.

The department should have a designated safety officer assigned to develop and implement a departmental safety program. Safety procedures should be strictly enforced, and all injuries should be carefully investigated. An employee safety committee is strongly recommended as well in order to get employees involved in the process and to provide a forum for employees to express their concerns.

It is often standard practice to assign a safety officer at working structure fires or other large-scale operations. In fact, a safety officer, and often an assistant safety officer, is *required* at hazardous materials incidents. These positions are built into the Incident Command System.

Physical Fitness

The greatest cause of fire fighter line-of-duty deaths is heart attack. Job stress (both physical and emotional) and exposure to smoke and toxic fire gases make fire fighters more susceptible to cardiovascular and respiratory disease than the general population. A good physical fitness program, which includes both medical check-ups and cardiovascular exercise, can greatly reduce the risk of both death and injury. It may also include a weight control program and nutrition education. Fire fighters should also be discouraged from smoking since this greatly increases the risk of cardiovascular and respiratory disease.

Training

Effective training is perhaps the single most effective way to improve fire fighter safety. Fire fighters must know how to perform each task safely, the hazards associated with each task, and how to protect themselves from those hazards. They must be confident and competent in their skills. And, they must train as a team so that they can function smoothly and efficiently with other fire fighters. Annual performance evaluations are an effective way to make sure that fire fighters stay sharp on their skills, particularly the ones they do not use quite as often.

Proper training can be even more of a concern in volunteer departments or paid departments with supplemental volunteer fire fighters because volunteers may not have a regular training schedule the way paid fire fighters do. Attendance at drills may be less consistent because of the "volunteer" status of those fire fighters.

Protective Equipment

Many fire fighter injuries can be prevented through the conscientious use of personal protective equipment such turnouts, helmets, gloves, SCBA, and personal alarm devices.

Fire fighters must be provided with the proper equipment for the specific tasks. It is inappropriate, for example, to have fire fighters mitigating a hazardous materials incident in standard turnouts. Many chemicals will penetrate or permeate the fabric. Special chemical protective equipment is required.

Equipment must fit properly in order to be effective. Equipment that is either too large or too small may restrict movement or otherwise hamper the fire fighter in the performance of his or her duties. It may be more subject to rips, tears, and other forms of damage. And, if the equipment is not comfortable, fire fighters may be inclined to remove it and work without it. Proper fit has always been an issue with fire fighters that are either large or small in stature as compared to the "average." However, this is becoming more of an issue with the increasing number of women in the fire service.

Damaged equipment must be taken out of service and repaired or replaced as appropriate. Equipment that has become contaminated must be decontaminated or disposed of and replaced. Contamination may be in the form of chemicals, ashes, and soot from a fire, or blood and body fluids from an injured victim.

Of particular importance is self-contained breathing apparatus. Again, heart attacks and cardiovascular disease are the leading cause of fire fighter deaths. Protection of the respiratory and cardiovascular systems is essential. One of the greatest risks to fire fighters is during the overhaul stage of a fire. Many fire fighters will remove their SCBA once the smoke has dropped to a "tolerable level." However, there are often high levels of carbon monoxide present during overhaul. The department should have Standard Operating Procedures for monitoring the atmosphere in the room or building to ensure that carbon monoxide levels are within recommended exposure limits before fire fighters remove their SCBA.

Appropriate Risk Assessment

Every fire fighter accepts that there are certain amounts of risk inherent in the job. There are even times when a fire fighter may risk his or her life in order to rescue another person in danger. Yet, most fire fighter deaths and injuries are not associated with rescue operations. They occur either when the fire fighter takes risks unnecessarily, such as to save property versus a life, or when the fire fighter fails to adequately assess the risks of a dangerous situation. Adequate risk assessment and good judgment are essential for every fire officer.

Prompt Follow-Up to Injuries and Exposures

When an injury or exposure does occur, it is important that appropriate measures are taken to handle the problem so that it does not escalate. A wound that becomes infected will need more extensive medical care than one that was properly cleansed and treated when it occurred. A sprain or strain may become much worse if not rested. Skin or clothing contaminated with chemicals or other harmful substances (such as poison oak or ivy) should be decontaminated as soon as possible to minimize the harmful effects.

The importance of reporting injuries cannot be overemphasized, particularly in the fire service. It is not uncommon for fire fighters to avoid reporting injuries. The reasons are numerous: not wanting to show weakness, not wanting to be bothered with paperwork and doctors, or not wanting to be assigned to "light duty," just to name a few. However, reporting injuries is important, not just for the injured fire fighter but for everyone in the department. It helps to identify trends or problems that may cause injury to others.

NFPA 1500, Standard on Fire Department Occupational Safety and Health

NFPA 1500, *Standard on Fire Department Occupational Safety and Health* was written in order to reduce the risk of death or injury to fire fighters. It is also geared toward making fire fighters healthier and more physically fit. NFPA 1500 was drafted by a committee of fire chiefs, company officers, line fire fighters, and union officials representing both career and volunteer fire departments. Other members of the committee included apparatus and protective equipment manufacturers, independent experts, and representatives of the United States Fire Administration.

As an NFPA standard, NFPA 1500 is not a mandatory requirement for any fire service organization until it has been adopted by an authority having appropriate jurisdiction. It describes the elements of an occupational safety and health program that has been accepted as the minimum level of care that should be provided in the fire service today. All fire departments are being encouraged to comply voluntarily with the standard.

Basic Components of NFPA 1500

The following is a brief overview of the basic components of NFPA 1500. It is not intended to be a comprehensive list of all requirements.

- ❑ The department is required to identify a safety officer. More information is provided in NFPA 1501, *Standard for Fire Department Safety Officer.*
- ❑ An occupational safety and health committee must be established, made up of a cross section of fire department members.
- ❑ The department must have a data collection system to track accidents, injuries, illnesses, deaths, and occupational exposures to toxic substances or contagious diseases. Records of related activities such as training of personnel, and inspection, maintenance and repair of vehicles and equipment should also be maintained.
- ❑ Members must be adequately trained to perform their duties in a safe manner. Training must include not only basic fire fighting, but also procedures for handling any special hazards that the fire department might respond to (i.e. hazardous materials incidents and confined space rescues). Training must be based on written standard operating procedures (SOPs). Fire fighters who have not been fully trained must be closely supervised by qualified, experienced personnel. Their emergency scene duties must be limited to those that fall within their training and capabilities.

- Fire fighters must be seated on fire apparatus, with seat belts fastened, before the vehicle moves or any time the vehicle is in motion. Riding tailboard is prohibited. The standard only recognizes riding in enclosed areas as being safe. Canopy areas that are open to the rear are acceptable on existing apparatus. However, the new requirements of 1901 will mandate four-door, fully enclosed cabs on all new fire apparatus.
- Fire apparatus and equipment must be inspected periodically and after each use to identify unsafe conditions. Any deficiencies found during these inspections must be corrected before the vehicle or equipment is placed back in service.
- Hearing protection is required for anyone exposed to vehicle or equipment noise in excess of 90dB.
- The fire department is required to provide full protective clothing and self-contained breathing apparatus (SCBA) to all members who will be exposed to the hazards of structural fire fighting. Other protection must be provided as appropriate for the hazards of each particular activity. The items must comply with appropriate NFPA standards. The department must also ensure that all protective clothing is used properly.
- Precautions must be taken to ensure that personnel are available to assist if someone is injured. These precautions include working in pairs (the Buddy System) and having someone outside a hazardous area that will be accountable for the crews working inside. In imminently hazardous situations, such as hazardous materials incidents or confined space or below-grade rescues, a safety officer must be assigned, a back-up rescue team must be ready to assist, and qualified emergency medical support personnel must be standing by with medical equipment and transport capability.
- An incident command system must be used to manage personnel and operations at the scene of an emergency. This incident command system must be based on written procedures that identify the roles and responsibilities relating to the safety of emergency operations.
- Emergency operations must be limited to those that can be accomplished safely with available personnel. The standard includes a strong recommendation for minimum staffing of four fire fighters on engine and truck companies.
- Fire stations and fire department facilities must comply with all legally applicable health, safety, building, and fire codes. Requirements include smoke detectors in all sleeping areas, monthly health and safety inspections, a 1-hour separation between apparatus rooms and living areas, and a vehicle exhaust system. Automatic sprinkler protection is recommended.
- The department must provide annual physical examinations and a structured physical fitness program. The established standards for fitness must be job-related. The department is required to establish a health database to track exposures and occupational illnesses.
- There must be a program in place to protect against occupational exposures to contagious diseases.
- The department should also have a program in place to support overall employee wellness, with components that deal with substance abuse; stress, including critical incident stress debriefing; smoking cessation; and other personal and family problems.

NFPA 1500 is available through the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269. NFPA 1500 is also contained in Volume 8 of the *National Fire Codes,* 1991 edition.

California's Workplace Injury and Illness Prevention Program

The California Labor Code (Section 6400) requires that every employer in California (including government agencies) provide and maintain a safe and healthful workplace for employees. A written, effective injury and illness prevention program is required by the California Code of Regulations (Title 8, Section 3203). It is beyond the scope of this course to go into detail on the requirements of the Injury and Illness Prevention Program. However, every fire officer should be aware of the basic components because managers at all levels are expected to contribute to the effectiveness of the program. The basic components include:

- ❑ Management commitment and identification of the person(s) with authority for implementing the program.
- ❑ A system for communicating with employees on matters regarding occupational safety and health. This may include training, safety committees, and written communications. This must also include a provision for employees to notify management about hazards without fear of reprisal.
- ❑ A system for ensuring that employees comply with safe and healthy work practices. Substantial compliance with this provision includes employee recognition for safe performance, training programs, and disciplinary actions for safety violations.
- ❑ Procedures for identifying and evaluating workplace hazards, including scheduled periodic inspections to identify unsafe conditions and work practices. This must be done when the Injury and Illness Prevention Program is first established; whenever new substances, processes, procedures, or equipment that represent a new hazard are introduced into the workplace; and whenever the employer is made aware of a new or previously unrecognized hazard.
- ❑ A procedure to investigate occupational injury or illness.
- ❑ Methods and/or procedures for correcting unsafe or unhealthy conditions, work practices and work procedures in a timely manner based on the severity of the hazard.
- ❑ Safety training and instruction for all new employees; for all employees given new job assignments for which training has not previously been received; whenever new substances, processes, procedures or equipment are introduced into the workplace and represent a new hazard; whenever the employer is made aware of a new or previously unrecognized hazard; and for supervisors to familiarize them with the safety and health hazards to which employees under their immediate direction and control may be exposed.
- ❑ Record keeping and documentation. Such records include, but are not limited to, documentation of safety inspections, any hazards found and the corrective action taken; training records; minutes of safety committee meetings; and accident investigation reports.

Again, this is just a brief overview of the requirements. However, it should be clear to any fire officer that he or she plays a key role in many of the components listed above.

More information on the Workplace Injury and Illness Prevention Program can be obtained from the Cal/OSHA Consultation Service. Their headquarters are located at 455 Golden Gate Ave, Room 5246, San Francisco, CA 94102. Their telephone number is (415) 703-4050.

Fireground Safety Practices

Most fireground safety practices are well known and involve simple common sense. The following are some basic guidelines that should be used at all fires:

- Wear full turnouts and protective equipment, including hoods (if provided by your department) and gloves.
- Use SCBA and personal alarm devices any time you may be exposed to smoke, toxic fire gases, or hazardous materials. Someone should be assigned to monitor the atmosphere to determine the concentration of contaminants in the air. However, if you feel you are being exposed, do not wait for instrument confirmation. When in doubt, use your SCBA.
- Stay low in hostile environments filled with smoke and heat.
- Work in pairs inside a building. Use the buddy system.
- Be aware of your surroundings. Stay alert to potential hazards. Continually monitor building integrity. When in doubt, get out. Make sure that the Incident Commander and Safety Officer are aware of any life safety hazards so that they may plan accordingly.
- Do not run on the fireground.
- Secure utilities as soon as possible.
- Use proper tools for the job, and use those tools properly.
- Establish and maintain adequate communications among the crews. Keep in mind that with all the noise and activity on the fireground it may be difficult for people to hear you or to properly distinguish the words being said. It is often helpful to have the other person repeat back what you have said just to confirm that they heard you properly.

Remember that many injuries take place during "unspectacular" activities such as overhaul operations. Some of those injuries occur because fire fighters become complacent and remove SCBA or gloves too soon. They may forget to lift with their legs instead of their backs because they are tired. This is also the time when many fire fighters are exhausted from rescue, exposure protection, and extinguishment activities. They may need to take time out for "rehab" before continuing.

Summary

Fire fighting is one of the most dangerous occupations in the country. Nevertheless, many fire fighter deaths and injuries can be prevented by an effective safety program which includes management support, physical fitness programs, training, proper protective equipment, appropriate risk assessment and prompt follow-up to injuries and exposures. Safety procedures should be communicated to all employees and strictly enforced throughout the department.

Chapter Review Questions

1. What is the greatest cause of fire fighter deaths in the line of duty? What is the best way to reduce this risk?

2. What is cited as perhaps the single most effective way to improve fire fighter safety?

3. What are some recommended guidelines regarding when SCBA can be removed at a structure fire?

4. What are the six areas of emphasis regarding fire fighter safety cited in this chapter?

5. What are some of the basic components of NFPA 1500, *Standard on Fire Department Occupational Safety and Health*?

6. What are the eight basic components of the Injury and Illness Prevention Program required in California?

7. Where are the regulations found for the workplace Injury and Illness Prevention Program?

8. List some of the basic guidelines for fireground safety.

Topic 18: Size-up

Size-up is a critical component of any emergency response; it is the basis for all decisions that follow. A good size-up lays the foundation for successful incident mitigation. On the other hand, if a fire officer does not perform an adequate size-up, the results can be disastrous. Your safety and the safety of everyone else on-scene depends on doing size-up properly.

What is Size-up?

Lloyd Layman, in his book *"Fire Fighting Tactics,"* describes size-up as the process of evaluating an incident in order to determine which course of action to pursue. Size-up is an ongoing process done not just once, but throughout the duration of the incident. It begins with the initial receipt of the alarm.

Initial size-up is done by the first-in officer, and is continued by any additional officer(s) who might respond and assume command. However, responsibility for size-up is not limited to the Incident Commander. As the incident escalates and ICS is expanded, each division or sector officer will perform size-up within their areas of operation and report that information back to the command post.

The process of size-up must be systematic and thorough. There are a number of specific factors that must be addressed when sizing up an incident. To miss any one of these factors may be to overlook critical information that is essential to the safety of personnel on-scene or to successful control of the emergency. Once again, size-up is the basis for the strategy and tactics employed during the incident.

Information Sources

The Incident Commander often utilizes multiple information sources in performing the size-up process.

Personal Observation

Initial size-up consists primarily of personal observation. What is visible to the fire officer upon arrival and throughout the incident? It often involves other senses besides just sight. The fire officer must be alert to sounds that might indicate such things as an impending structural collapse or the presence of unstable containers of hazardous materials. He or she must be aware of odors that might suggest the presence of toxic substances. This personal observation is normally done from outside the building.

Reconnaissance

Some of the information needed for a complete size-up will not be visible to the Incident Commander from the Command Post. The Incident Commander will have to rely on input from other officers on-scene. He or she will generally need to assign someone to go check out an area or a situation and report back. This process is known as reconnaissance.

Preplanning

Facility preplans can be a tremendous resource to the Incident Commander. They provide information on the layout of the facility, hazards that might be anticipated, fire protection features, and sometimes even suggested tactics and strategies for dealing with specific emergencies. Some of this information may be very difficult to obtain during an actual incident; particularly after-hours when on-site facility personnel may not be available.

On-site Resources

Of all the information sources, this is perhaps the least reliable. Facility representatives are seldom experienced in responding to emergencies, unless the facility has its own Emergency Response Teams. On-site personnel may underestimate or overestimate the extent of the emergency. However, they can also be a valuable resource by providing information that might otherwise be unavailable to the Incident Commander. It is a good idea for fire officers to become acquainted with on-site emergency response teams during preplanning activities, and to get a feel for their capabilities during an emergency.

Lloyd Layman's Size-up System

Lloyd Layman has broken size-up into five distinct components:

Major Components of Size-up
Facts
Probabilities
Own Situation
Decision
Plan of Operation

Each of these components involves several different factors:

<table>
<tr><th>Facts</th><th>Probabilities</th></tr>
<tr><td>Data available through preplanning
Data acquired upon receipt of the alarm
Data acquired upon arrival or observed at the scene
Implementation of policies or SOPs based on observed facts</td><td>Anticipated fire growth
Anticipated threat to life
Anticipated threat to property and the environment
Reflex times
Weather changes
Abnormal conditions influencing the state of emergency</td></tr>
<tr><th>Own Situation (Resources)</th><th>Decisions</th></tr>
<tr><td rowspan="3">Apparatus
Personnel
Equipment
Cooperating agencies available
Extinguishing agents
Fire protection equipment on site</td><td>The initial decision(s)
Supplemental decisions</td></tr>
<tr><th>Plan of Operation</th></tr>
<tr><td>Issue orders/instructions that will initiate actions
Provide management and supervision</td></tr>
</table>

Activity 18-1

TITLE:	Size-up
INTRODUCTION:	This activity takes a more detailed look at each of the size-up factors identified by Lloyd Layman. It will help you prepare for the simulation portion of this course.
DIRECTIONS:	1. Individual factors are listed in the left column. 2. The right column provides space for you to identify how they may impact the tactics and strategies you decide to use. 3. A few have been filled in as examples. 4. This may be completed during lecture, as part of a group exercise or as a homework assignment. 5. Be prepared to discuss your answers with the class.

FACTS

Data available through preplanning

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Location	
Occupancy classification	This will impact occupant load, construction, and requirements for fire protection features.
Occupant load	
Structural type	
Internal and external building features	
Required fire flows	
Available fire flows	
Fire load	
Built-in protection systems	They will assist in confining and/or extinguishing the fire. It may be necessary to assign a company to handle the system.

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Topography	
Access routes at the site	
Anticipated fire behavior	
Ambient weather	
Anticipated operational priorities	

Data acquired upon receipt of the alarm

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Nature of the emergency (description of the problem)	As given by the reporting party
Time of day	
Number of responding units	
Weather conditions	

Data acquired upon arrive or observed at scene

INDIVIDUAL FACTORS	POSSIBLE IMPACT
True nature of incident (fire, haz mat incident, vehicle accident, medical emergency)	As observed by the fire officer. May be different than the problem described by the reporting party.
Ease of access to location	
Location, intensity and color of fire or smoke	
Nature of threat to life or property	

Implementation of policies or SOPs based on observed facts

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Officer must know how much authority he or she has	
Departmental policies on deployment of apparatus and equipment must be followed	
Departmental policies on the handling of specific problems must be followed	

PROBABILITIES

Anticipated fire growth

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Direction (vertical, horizontal)	
Intensity	
Effects of heat and smoke	

Anticipated threat to life

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Occupants	
Fire department personnel	
Police and other officials	
Bystanders	
Unaware citizens	

Anticipated threat to property and the environment

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Direct damage (Flame spread, heat, smoke)	
Indirect damage (Smoke, water)	

Reflex times

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Required for evolutions	
Required for assistance	Additional alarm assignments or other resources should be ordered early.

Weather changes

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Wind speed and direction	
Temperature	
Humidity	
Inversions	
Abnormal conditions	

Abnormal conditions influencing the state of emergency

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Structural deficiencies and failures	
Accelerated fire behavior	
Explosions	
Lack of time for normal operations	

OWN SITUATION

Apparatus

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Type and number on-scene	
Type and number responding	
Type and number available	

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Configuration of hose loads	

Personnel

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Staffing levels on-scene	
Staffing levels responding	
Staffing levels available	
Performance capabilities and limitations of companies	
Command and control organizational structure	
Staff support available	

Equipment

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Equipment inventories	
Specialized equipment on the scene	
Specialized equipment available	

Cooperating agencies available

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Police	
Utility and public works departments	
Mutual aid, citizens	
Staff support (chemists, researchers, etc.)	

Extinguishing agents

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Water	Available fire flow, applied fire flow capabilities
Foams	
Powders	
Gases	

Fire protection equipment on site

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Sprinkler system	
Standpipe system	
Smoke detectors	
Fire alarms	
Special extinguishing equipment	
Smoke and heat vents	To assist with ventilation.
Fire doors and windows	To help confine fire and smoke.
Fire walls, division walls	To help confine fire and smoke.

DECISIONS

The initial decision(s)

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Must be made in light of the primary mission of protecting lives and property	
Must be based on the accomplishment of objectives for companies or personnel	
Must be made objectively and as quickly as possible	

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Must be made in light of all known threat potentials	
Must be made in light of all priorities and utilization of resources	
Must be made in view of the integration of efforts with resources	

Supplemental decisions

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Must consider the effects of the control effort on the problem	
Must consider the effects of the problem on the control effort	
Must consider the input of new facts on the nature of the problem	
Must be a continuous process until the emergency is completely over	
Must consider input of the staff in reassessing conditions	

PLAN OF OPERATION

Issue orders/instructions that will initiate actions

INDIVIDUAL FACTORS	POSSIBLE IMPACT
An overall strategy	
The setting of tactical objectives	
The selection of methods that will be employed	

Provide management and supervision

INDIVIDUAL FACTORS	POSSIBLE IMPACT
Adhere to sound management principles	
Utilize appropriate management techniques	
Exercise command	

Mental Discipline

Knowledge of these components and factors alone will not ensure an adequate size-up. It takes mental discipline to know what information is important and how to use that information in the decision making process that follows.

Dealing with Facts

The number of facts observed or available to the Incident Commander can be enormous. Not all of them are relevant or immediately important. They must be filtered and screened so that only the most relevant are dealt with initially. The individual facts must be evaluated in terms of how they fit into the overall "big picture."

The Probabilities

The Incident Commander must look ahead at probable hazards or concerns. Once again, there can be a large number of them. In order to focus on the most important, the distinction must be made between those that are fairly probable and those that are remote possibilities. Initial attention must be devoted to those that are most likely and those that present a high degree of risk to personnel on-scene.

Resources

The fire officer must never hesitate to "think big." Turning back units will always be easier than requesting them when you have run out of resources and you are surrounded by the enemy. It is important to remember that your resources extend beyond your initial response. It is also important to remember that your resources include reference items such as prefire plans, maps, and building guides.

Decisions

A good fire officer will try to not make decisions before obtaining pertinent facts, just as a successful football quarterback will not throw the ball before knowing who is open. Use all of your senses and those of your fellow fire fighters in gathering as much pertinent information as possible before committing your resources. Then, after committing your resources, remember that your decisions are not cast in concrete. Stay flexible and receptive to continual input. Constantly review and assess the effectiveness of your decisions.

Plan of Operation

The original plan of operation may require modification or change on occasion. The fire officer must constantly monitor and evaluate the effectiveness of the plan. Management and supervision must be continually exercised. Issuing orders and instructions will be an important aspect of the plan's operation.

Specific Fireground Factors

The previous pages dealt with the overall operations at the fire scene. The following list focuses more on the fire itself, the people and structures it impacts, and the resources needed for suppression activities. These fireground factors are listed as an example of the thoughts that will quickly pass through an experienced fire officer's mind en route and upon arrival.

The Building

- ❑ Size
- ❑ Interior arrangement/access (stairs, hallways, elevators)
- ❑ Construction type
- ❑ Age
- ❑ Condition of the building (faults, weaknesses)
- ❑ Compartmentation/separation
- ❑ Vertical and horizontal openings (including shafts and channels)
- ❑ Outside openings (doors and windows, degree of security)
- ❑ Utilities (hazards, methods for control)
- ❑ Concealed spaces, attics
- ❑ Exterior access
- ❑ Effect the fire has had on the structure thus far
- ❑ Time projection on continuing fire effect on building

Fire

- ❑ Size
- ❑ Extent (% of structure involved)
- ❑ Location
- ❑ Stage
- ❑ Direction of travel (most dangerous)
- ❑ Time of involvement
- ❑ Type and amount of material involved - structure/interior
- ❑ Finish/contents/everything
- ❑ Type and amount of material left to burn
- ❑ Product of combustion liberation

Occupancy

- ❑ Specific occupancy
- ❑ Type (group) (business, mercantile, public assembly, institutional, residential, hazardous, industrial, storage, school)
- ❑ Value characteristics associated with occupancy

- ❑ Fire load (size, nature)
- ❑ Status (open, closed, occupied, vacant, abandoned, under construction)
- ❑ Occupancy associated characteristics/hazards
- ❑ Type of contents (based on occupancy)
- ❑ Time - as it affects occupancy use
- ❑ Property conservation profile/susceptibility of contents to damage/need for salvage
- ❑ Moral hazard

Life Hazard

- ❑ Number of occupants
- ❑ Location of occupants
- ❑ Condition of occupants (by virtue of fire exposure)
- ❑ Incapacities of occupants
- ❑ Commitment required for search and rescue (personnel, equipment, command)
- ❑ Fire control needed for search and rescue
- ❑ Needs for EMS
- ❑ Time estimate of fire effect on victims
- ❑ Spectators (possible hazards to spectators, need for crowd control)
- ❑ Hazards to fire personnel
- ❑ Access to victims needing rescue
- ❑ Characteristics of escape routes/avenues of escape (type, safety, fire, condition, etc.)

Arrangement

- ❑ Access, arrangement, and distance of exposures (internal and external)
- ❑ Combustibility of exposures
- ❑ Severity and urgency of exposure (fire effect)
- ❑ Value of exposures
- ❑ Most dangerous direction - avenue of fire spread
- ❑ Time estimate of fire effect on exposure (internal and external)
- ❑ Obstructions to operations
- ❑ Capability/limitations on apparatus movement and use

Resources

- Personnel and equipment on-scene
- Personnel and equipment responding
- Personnel and equipment available in reserve
- Estimate of response time for personnel and equipment
- Condition of personnel and equipment
- Capability and willingness of personnel
- Capability of commanders
- Nature of command systems
- Number and location of hydrants
- Supplemental water sources
- Adequacy of water supply
- Built-in private fire protection (sprinkler, standpipe, alarms)
- Outside agency resource and response time

Other Factors/Conditions

- Time of day/night
- Day of week
- Season
- Special hazards by virtue of holidays, special events
- Weather (wind, rain, heat, cold, humidity, visibility)
- Traffic conditions
- Social conditions (strikes, riots, mobs, rock festival, union meeting)

Size-up and Divisions of Fire Fighting

The process of sizing-up an incident requires evaluating the situation, and then applying that information to the divisions of fire fighting. In other words, size-up involves looking at both problems and solutions/objectives.

This process can take the form of questions such as:

- What are the facts concerning rescue?
- What is the probability of rescue being needed?
- What resources are available to conduct the rescue?

- ❑ What decisions must be reached regarding rescue?
- ❑ What will the rescue plan entail?

Each of the examples above is geared specifically towards rescue. However, the process is repeated for each of the other fire divisions (exposures, confinement, extinguishment, overhaul, ventilation and salvage). The process can be interrupted or modified as the situation dictates. For example, if the facts and probabilities concerning rescue indicate that rescue operations are not needed, there is no point assessing your resource capabilities or establishing a rescue plan.

Application of Size-up

Fire officers do not often have the opportunity to command large incidents. As a result, they may find that their skills are not as sharp, that they are more likely to make mistakes, and that there is an increased threat to life and property.

It is important for fire officers to practice the size-up process. This mental evaluation can be applied to all responses, regardless of size or complexity. Regular practice will increase the fire officer's mental skills, enhance mental discipline, and allow the process to become a habit. Practice will reduce the frequency and impact of "surprises," as well as the mental lapses that can occur at a major emergency. It will better prepare the officer to assume a command role.

Size-up is an essential component of command. Lloyd Layman, in his book *"Fire Fighting Tactics,"* states, "Individuals who are unable to maintain self-control and to think clearly and logically amid confusion and excitement on the fireground should not aspire to positions of operational command."

Summary

Size-up is a critical component of any emergency response; it is the basis for all decisions that follow. Lloyd Layman describes size-up as the process of evaluating an incident in order to determine which course of action to pursue. It is an ongoing process that is done throughout the duration of the incident. The Incident Commander often uses multiple information sources in performing the size-up process: personal observation, reconnaissance, preplanning, and on-site resources. Size-up can be broken into five distinct components: facts, probabilities, own situation, decision, and plan of operation. Each of these components involves several different factors. It also takes mental discipline to know what information is important and how to use that information in the decision making process that follows.

Chapter Review Questions

1. What is size-up?

   ____

   ____

   ____

2. What is the value of doing a good size-up?

3. What information sources are available to the Incident Commander in performing the size-up process?

4. What are the five major components of size-up?

5. How does "mental discipline" help the fire officer with size-up?

6. How can regular practice of the size-up process help the fire officer?

Activity 18-2

TITLE:	Size-up and Divisions of Fire Fighting
DIRECTIONS:	1. For each of the incidents listed below, discuss the individual factors that you will evaluate during your size-up process and how you will apply that information to the various divisions of fire fighting. 2. Be prepared to discuss your answers with the class.

Size-up Factors	**Divisions of Fire Fighting**
	Rescue
Facts	Exposure Protection
Probabilities	Confinement
Own Situation	Extinguishment
Decision	Overhaul
Plan of Operation	Ventilation
	Salvage

INCIDENTS

1. Trash bin fire.

____

____

2. Smoke odor in a structure.

____

____

3. Medical aid, two victim.

____

____

4. One room fire in a residential occupancy.

____

____

Topic 19: Strategy, Tactics, and Methods

Fireground decisions are made on three different levels consisting of a strategy, tactics, and methods. It is important for the fire officer to recognize these three levels, as well as the major components of each.

Strategy

A strategy is a basic plan that identifies major goals and prioritizes objectives. Strategic decisions are based on the fire officer's perceptions of the situation present.

Components of this strategy are based upon the officer's size-up, mode of attack and strategic priorities. As discussed before, the size-up will involve the first responder's data collection abilities as well as his or her experience. The fire officer needs to evaluate the facts, the probabilities, his or her own situation (resources and capabilities), available options or decisions rendered, and any plan of operation implemented. This is the process known as "size-up." It is during the last two phases of size-up (decisions and plans) that the strategy is established.

The *mode of attack* is the operational process determined by the size-up, and may be either offensive or defensive in nature or a combination of thereof. The mode of attack will possibly be one of the most significant factors in the success or failure of the operation.

Offensive Strategy

An offensive strategy is utilized when the fire is small or when the attack is made directly on the main area of the fire. The purpose of this attack is to completely control the entire fire. It is defined as a strategy where sufficient personnel and equipment are available to generate enough fire flow (GPM) to extinguish the fire. Offensive strategy is close-up, aggressively fought, and then followed up with other forces completing support functions such as control of utilities, salvage, etc. It is generally an interior attack.

Defensive Strategy

A defensive strategy is where the fire is generating so much heat (BTUs) that the fire fighting forces cannot deliver sufficient GPMs (fire flow) to extinguish it.

A true defensive strategy involves protection of exposures only. Although heavy streams may be deployed, there are none of the advancing qualities found with offensive strategies. This is generally a "surround and drown" operation.

Combination Strategies

Combination strategies will have both offensive and defensive qualities, and they may occur in either order. For example, first arriving companies are often committed to protecting one side of the building, confining the fire or keeping it within reasonable limits. Their efforts are then augmented by additional companies who take up the offensive mode upon arrival. When the first-in unit completes their objective, they may be reassigned to attack operations. Or, a gambling type attack can be made as a combination strategy when an officer believes that rapid control of a fire is possible. The primary force is deployed directly on the area of major involvement, perhaps with large lines, while smaller or fewer numbers of lines are used to stop extension. A combination strategy of this type is often based on undefined or unknown fire extension with the officer making contingency plans for stopping the fire with larger or better positioned lines should extension be more than first suspected.

Determining Strategic Mode

The strategic mode should be determined by comparing the resources available to apply the necessary GPM while successfully accomplishing the other necessary tasks of rescue exposure protection, etc.

Ask yourself the question:

Can I handle the emergency with the resources available?

Yes = Offensive Strategy

No = Defensive Strategy

Maybe = Combined Strategy

The officer's strategic priorities are then set into motion using either RECEO, REVAS, or any other appropriate system outlined in department SOPs.

Tactics

Tactics are specific individual objectives that must be completed to accomplish the overall goal(s) or strategy. They are based on tactical priorities of search and rescue, exposure protection, confinement, extinguishment, overhaul, ventilation and salvage. These are covered in detail in the chapter on "Divisions of Fire Fighting."

Methods

Methods, or tasks, are the individual evolutions conducted to accomplish the tactical objectives. For example, the tactical objective of search and rescue may require multiple tasks such as hose and pumping evolutions to provide a safety line; forcible entry to get into the structure; search procedures; and the use of appropriate lifts, drags or carries to get the victim out. It may require coordination of multiple companies; one may need to place ladders for bringing a victim out an upper story window, while another ventilates the roof to allow smoke and heated gases to escape.

Methods are based upon existing company evolutions and performance standards. The methods employed may depend on the resources available and their individual capabilities. They are usually decided by the company officer and his or her crew.

Summary

Fireground decisions are made on three different levels: strategy, tactics, and methods. A strategy is a basic plan that identifies major goals and prioritizes objectives. One of the most fundamental decisions that must be made in developing a strategy is mode of attack (offensive or defensive). Tactics are specific individual objectives that must be completed to accomplish the overall goal(s) or strategy. They include the tactical priorities of search and rescue, exposure protection, confinement, extinguishment, overhaul, ventilation and salvage. Methods, or tasks, are the individual evolutions conducted to accomplish the tactical objectives. They are usually decided by the company officer and his or her crew.

Chapter Review Questions

1. Define the following:

   Strategy: ______________________________

   Tactics: ______________________________

   Method: ______________________________

2. What three components form the basis for determining strategy?

   ____

   ____

3. When would it be appropriate to use the following modes of operation?

   Offensive attack: ______________________________

   Defensive attack: ______________________________

   Combination attack: ______________________________

4. How should the appropriate strategic mode be determined?

   ____

   ____

5. Who usually decides the methods used to accomplish tactical objectives?

   ____

   ____

Topic 20: Report on Conditions

Communications will always be a vital link in any emergency response operation. This is particularly true of the report on conditions provided by the first-in fire officer. He or she is the eyes and ears of the other response personnel that follow. A timely and accurate report on conditions allows other personnel to better prepare themselves mentally for the tasks ahead and to begin planning the evolutions they will need to perform.

The report on conditions is also the time when the first-in fire officer generally assumes command of the incident. However, he or she may choose to pass command to the next-in officer because of a need to delve right into some hands-on operation.

Components of the Report

A report on conditions should contain the following information:

- ❑ Notification of arrival on-scene.
  - This establishes time of arrival. It may also include an updated address or location if the different from the one initially reported.
- ❑ Type of structure or area threatened.
  - A brief description of the occupancy, construction type, building size, vehicle, terrain or other area impacted helps other responding crews anticipate potential problems they may encounter, as well as fire protection features which may assist them in their suppression efforts.
- ❑ Occupancy status.
  - Whether a building is occupied or vacant will impact the need for rescue.
- ❑ Statement of actual conditions.
  - This is a brief statement of what is visible (or not visible) to the fire officer upon arrival, as well as the degree of involvement. It includes an identification of immediate problems.
- ❑ First-in company's proposed course of action.
  - This is the assignment or task that the first-in company will be responsible for.
- ❑ Instructions to other responding units.
  - This may include response routes, where to position apparatus once on-scene and operational assignments.
- ❑ An estimation of resources required.
  - Can this incident be handled by the units on-scene or will this require an additional alarm assignment?

- ❑ Implementation of the command structure.
  - At this point, the officer will generally identify himself or herself as the Incident Commander and provide a name for the incident.

Although this list may appear lengthy, it actually takes but a few moments to compose and transmit. Even if not all the facts relative to the emergency are known when the report on conditions is given, this information is extremely valuable in setting the stage for all subsequent operations on the scene.

Radio Procedures

Knowing how to provide a radio report is just as important as knowing what to say. If the transmission cannot be heard and understood, it might just as well not be given. Worse, yet, if the radio report is misunderstood it can have dire consequences.

The following are some good general guidelines for provide a clear, professional radio report:

- ❑ Pay attention to other radio traffic to avoid cutting off another transmission.
- ❑ Hold the microphone a couple inches from your mouth.
- ❑ Hesitate briefly after depressing the button on the microphone. If you start speaking too soon the beginning of your message will not be heard.
- ❑ Speak clearly and distinctly. Remain calm when giving your report so that your message will be understood.
- ❑ Use common language that will be understood by all. Many fire departments have moved away from "10 Codes" and other "jargon." They have gone instead to "clear text" to facilitate communication between agencies.
- ❑ Be brief, accurate and to the point. Provide only pertinent data. Avoid unnecessary transmissions.
- ❑ Augment the initial report, if necessary, to include any significant changes in the situation or updated objectives.

Summary

Communications are a vital link in any emergency response operation. A timely and accurate report on conditions allows other personnel to better anticipate the problems they may face and the role they are about to play in the incident.

Chapter Review Questions

1. What important information should be included in a report on conditions?

   ____

   ____

2. What are some of the guidelines that will permit the fire officer to give a clear, professional radio report?

Topic 21: Role of the First-in Officer

One of the most difficult decisions the first-in company officer must make is whether to remain with his or her company or to assume command of the fire. Although there may be a tendency to want to get directly involved in fire fighting operations, the first-in officer is pretty much obligated to take command.

The company officer must be familiar with the different roles that he or she may have to assume, the criteria for selecting the proper role, and how that selection might impact the overall incident.

The Role of the Company Officer

The company officer will generally end up assuming one of three roles: investigative, company member or command. The size and complexity of the incident are the major determining factors.

Investigative Role

The investigative role is appropriate on incidents where there is nothing showing upon arrival, and the first-in officer must determine whether or not there is a problem, and what that problem might be. This is not to be confused with the role of a fire investigator. Examples of incidents requiring the investigative role are smoke or gas investigations, small fires that were extinguished by building occupants where there is no visible fire or smoke upon arrival, and malicious or mechanical false alarms.

Responsibilities include providing a report on conditions over the radio, safely positioning the apparatus, and investigating the situation. The fire officer will need to check out the area or structure, as well as talk to the reporting party to determine what prompted the emergency call. He or she will then need to determine what further action is required, if any.

Company Member Role

On a nuisance or initial attack type fire that can be handled by a single unit, the fire officer will function in the company member role. He or she will still need to transmit a report on conditions and size-up the situation, though this size-up will be more involved than in the investigative role. The company officer will need to determine objectives and assign crewmembers accordingly. He or she may need to get involved in some of the hands-on suppression activities depending on what needs to be done and how many crewmembers are available to perform the tasks. He or she must monitor results throughout the operation, and request additional resources if it appears that they may be needed.

Command Role

A large or growing emergency that is well beyond the capability of the first-in company will require the officer to take the command role. There will still be a need to transmit a report on conditions, perform a size-up, determine objectives, and make assignments. Those responsibilities change only in size and scope. The first-in officer will need to call for or verify additional resources. He or she will need to formally assume command, designate a command post location, and be available to incoming officers. When a senior officer arrives, he or she will need to provide that officer with thorough information as command is officially transferred.

Determining the Appropriate Role

The examples cited on the previous page are fairly clear; the decision regarding which role to assume is easy. But, such is not always the case on the fireground. There are several factors to consider.

Perhaps the most common is evaluating whether or not that first-in company can handle the incident. If an immediate attack will extinguish or contain the fire, it makes the most sense to take the role of company member. On the other hand, if the fire is large and beyond the capability of that first company, one additional person on the nozzle will not make any difference in controlling the incident. The first-in officer will do more good assuming the command role.

What are the conditions on-scene? How far away is the next-due officer? Is there an immediate threat to life? If there's a rescue involved, the first-in officer will probably have to pass command to the next-in unit and work directly with his or her crew. If staffing is limited, the first-in officer may need to assist his or her crew if there's a possibility they may get hurt trying working without sufficient help. In either case, the first-in officer should provide sufficient information and instructions so that the officer arriving next does not have to repeat the size-up process.

The department may also have specific SOPs or guidelines for first-in officers. Each company officer must be familiar with them.

Command Considerations

An officer cannot properly command an incident while functioning as a company member. It is necessary to choose one role or another. The officer must be able to determine where he or she will do the most good. Any incident beyond the control of a single unit will require the command function, regardless of other demands. The first-in officer must not abdicate the role simply because he or she is not comfortable with it or would prefer to be directly involved in fire attack.

Knowledge of the Incident Command System is essential for orderly control of resources. It provides a template that makes the process much easier for the fire officer who might otherwise be overwhelmed by the magnitude of the incident.

Summary

A fire officer might assume three different roles, depending on the size and complexity of the incident. The investigative role is used for those incident where nothing is showing upon arrival and the officer must do some checking to determine what prompted the emergency call. When the incident is one that can be handled by a single company, the fire officer will function as a company member. Anything larger will generally require assuming the command role. However, there are exceptions to these guidelines. The fire officer must be able to determine where he or she will do the most good, while still ensuring that basic command functions are addressed.

Chapter Review Questions

1. List the three different roles that a fire officer must assume and give some general guidelines for each.

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2. What are some of the factors that must be considered in determining which role is most appropriate?

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Activity 21-1

TITLE:	Role of the First-in Officer
INTRODUCTION:	The following exercise is designed to give you an opportunity to perform a size-up and make some initial decisions regarding fireground operations.
DIRECTIONS:	1. Your instructor will provide you with a scenario using either a fire simulator or slides and any additional information concerning conditions found on arrival, resources available, level of response, time of day, and any other factors which affect the scenario. 2. Your instructor will also determine how many students will work in each group and how long each group will have to complete the activity. 3. In your group, complete the worksheet based on your scenario. 4. Be prepared to discuss your answers with the class.

FIREGROUND OPERATIONS WORKSHEET

1. Can you handle the situation with available resources? (Check one.)

   ☐ Yes

   ☐ No

   ☐ Undetermined

2. Which strategic mode of attack is recommended? (Check one.)

   ☐ Offensive

   ☐ Defensive

   ☐ Combination

3. What are your initial strategic objectives?

a. ______________________________
b. ______________________________
c. ______________________________

4. What role would you personally assume? (Check one.)

   ☐ Investigative

   ☐ Company member

   ☐ Command

5. What information would you include in your initial report of conditions?

   ____

   ____

   ____

Topic 22: Company Operations

Fire apparatus is designed and staffed to accomplish various operations and tasks required on the fireground. Traditionally these operations/tasks have centered around trucks and engines, although there are specialty units designed to cope with unique problems. Fire officers must be familiar with the operational capabilities of each.

Engine Company Operations

The engine is usually designed around the pump, thus engine company operations are centered around pumping and related activities. The activities may vary from one jurisdiction to another, but in general they involve performing search and rescue operations as necessary, applying water for exposure protection, confinement and extinguishment, utilizing built-in fire protection systems, and performing overhaul of the fire area. The engine company has primary responsibility for laying supply lines, and advancing and setting up attack lines or master streams.

Truck Company Operations

Truck operations may or may not involve the application of water; when they do, it is generally to provide elevated streams. More frequently, truck companies are involved in rescue operations, ventilation, laddering evolutions, forcible entry, control of utilities, performing salvage and overhaul, and assisting engine company crews with determining fire extension.

The Relationship between Engine and Truck Company Operations

Effective suppression efforts require the combination of both engine and truck work. For example, when the truck company is able to provide prompt and effective vertical ventilation, it creates a more tenable atmosphere inside the structure for engine companies performing search and rescue or suppression efforts. It also greatly reduces the risk of a flashover or backdraft. On the other hand, an engine company that can provide effective horizontal ventilation during their suppression efforts will reduce the time that truck companies need to spend on a roof which may be close to collapse.

Both engine and truck companies must coordinate the application of water from hand lines, master streams and elevated streams to avoid endangering other crews. Engine companies working inside the structure and truck companies working on the roof must be alert to signs of potential collapse, and must warn one another when their operations might impact someone above or below them. They function as individual crews, but must all work together as a team.

There is often overlap between the responsibilities of engine and truck companies. When the proper resources are not yet available, or when a particular company needs assistance in performing necessary functions, fire fighters must be prepared to take on additional activities. This is particular true in smaller departments that have limited staffing, or those that do not have truck companies. Engine companies will generally carry some truck equipment, and trucks are often designed with limited pumping capabilities and tank water, to permit these overlapping functions.

Fire officers must be careful not to develop tunnel vision and overlook the contributions of other companies in their concern to fulfill their own functions. The importance of engine company operations is generally well understood, because fire extinguishment usually depends on the application of water. But, there are times when truck company operations may take precedence over the deployment of hoselines. Examples include vertical ventilation to prevent a backdraft or to permit hoseline advancement, placing ground ladders for access to upper levels for rescue or hoseline placement, performing salvage in occupancies with high content value or obtaining an aerial view of the fire's growth and extension. Keep in mind however, that "taking precedence" does not mean that these operations should take place without due regard for safety. A truck company should not be on the roof venting directly above the fire without first sounding the roof, traveling over main structural members, monitoring fire conditions and coordinating with fire attack crews.

The fire officer must understand the roles of both engine and truck companies, and how those responsibilities are interrelated. They need to be able to recognize when resources are inadequate to perform the specific functions, and be ready to assign personnel different tasks as needed.

Summary

Most fireground operations center around engine and truck companies. There are different functions generally associated with each, but there is often overlap between the two. Fire officers must be familiar with the primary responsibilities of engine and truck companies, and how the various responsibilities are interrelated.

Chapter Review Questions

1. What are the functions typically associated with engine companies?

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   ____

2. What are the functions typically associated with truck companies?

   ____

   ____

3. List some examples of how engine and truck companies must work together to provide more effective suppression services.

   ____

   ____

Topic 23: Determining Resource Requirements

At every fire emergency, the fire officer in charge must make a determination of the resources that will be required to control the incident. One very critical resource is fire flow. The officer must be able to quickly calculate how much water is needed to extinguish the fire, and what resources will be required to deliver that water.

A Quick Field Formula for Calculating Fire Flow

The previous chapter provided information on how to calculate fire flow for prefire plans. But, detailed formulas won't help the fire officer at the time of an incident if a building hasn't been preplanned, or the preplan isn't immediately available. The fire officer needs a "quick and dirty" formula that will give him or her a reasonably accurate fire flow *right now*. That formula is as follows:

$$\text{GPM} = \frac{\text{Cubic Feet of Area Involved}}{100} \times \text{\% of Involvement} \times \text{Fuel Load Factor}$$

Cubic Feet of Area Involved

Cubic footage is calculated by multiplying the length, width, and height of the structure. To make it simple, the length and width should be rounded off to even numbers that are easy to work with. For example, a 100' x 40' structure should be rounded off to 100' x 50' to come up with 5000 square feet. A 90' x 120' structure could be rounded off to 100' x 100' even though the square footage is actually a little bit more.

The height of the structure should be expressed in 10-foot increments, again to make the calculations easier. A single story structure with a flat roof is approximately 10-feet high. Twenty feet, however, should be used to calculate the height of a single story dwelling with a high peaked roof.

Once the cubic footage is determined, that figure should be divided by 100. The number 100 is a constant.

Percent of Involvement

The percent of involvement should be indicated in increments of 25%. Therefore, the structure should be considered as 1/4, half, 3/4 or fully involved. Multiply by a factor of .25, .50, .75, or 1.00 as appropriate.

Fuel Load Factor

The value used for fuel load factor is based on occupancy type:

Value	Fuel Load	Examples (Occupancy Types)
1	Light	Dwellings, apartments, offices
2	Moderate	Mercantile, factories, shopping centers
3	Heavy	Refineries, warehouses, bulk plants

Certainly, this can be adjusted as needed. For example, most fire fighters have been to at least one house fire where the house and garage looked as if nothing had been thrown out for years. The fuel load factor might be considered as moderate instead of light. Obviously, this fire will need more water than a similar residential fire with a normal fuel load.

Multiple Stories

When a fire involves a single floor of a multiple story building, the calculations should be based on the height of the floor(s) involved or threatened, not the entire structure.

Estimate of gpm Required

To determine the fire flow in gallons per minute, take the cubic footage of the structure and divide that by 100. Multiply the result by the percent of involvement and the fuel load factor. This calculation provides the *minimum* amount of water (gpm) necessary to contain the fire within the involved area if the fire flow is applied efficiently. If any problems are anticipated, that number should be increased to ensure an adequate water supply.

The Resources Required to Deliver Needed Fire Flow

It is not sufficient just to calculate the required fire flow. The fire officer must make sure that he or she has sufficient resources to deliver the water needed. That includes knowing the pumping capabilities of the responding apparatus and the amount of personnel available.

As a rule of thumb, it can be anticipated that every fire fighter on-scene should be able to supply 80 to 100 gpm. Studies indicate that a four-person engine company will deliver approximately 500 gpm at a working fire. These two estimates provide slightly different results, but either can be used as a guide for determining the number of personnel or fire apparatus needed on-scene. Of course, additional resources will be needed for other activities such as rescue, exposure protection, ventilation, salvage, etc. These estimates are designed for fire flow only.

The other thing the fire officer must keep in mind is the time that it takes to get necessary resources on-scene. That includes both response time and the time it takes to receive instructions, lay lines and get water to the nozzle. If additional engines will be needed, they should be requested early.

Planning and Practice

Many of the questions regarding resource requirements can be answered prior to the emergency. Preplans should include information about fire flows, response times, access routes, and water supplies. If that information is not developed ahead of time, the fire officer will have to determine it as part of the size-up process.

Another valuable tool for determining resource requirements is simply practice. The department should have established performance standards. Each company should practice these not only individually, but as part of multi-company drills simulating the conditions that might be expected at target hazards in the community.

Summary

The fire officer has an important responsibility to determine resource requirements at a fire emergency. He or she must be able to quickly calculate required fire flow in the absence of a detailed prefire plan. And, he or she must be able to determine what resources will be required to deliver the needed fire flow.

Chapter Review Questions

1. What "quick and dirty" formula can be used to calculate fire flow in the field?

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2. How should the numbers for building length, width, and height be rounded off when calculating square footage?

   ____

   ____

   ____

3. How should percent of involvement be calculated?

   ____

   ____

   ____

4. How are fuel load factors determined?

5. How should multiple story buildings be calculated?

6. What two estimates can be used for determining the number of personnel or apparatus required to deliver the needed fire flow?

Topic 24: Apparatus Placement

The positioning of apparatus has a direct influence on the overall fireground operations. Proper placement will ensure the safety of response personnel and facilitate suppression activities. Incorrect placement can seriously hamper an officer's ability to achieve specific goals and objectives.

The responsibility of placing apparatus in the proper position rests with both the driver/operator who must know the capabilities of his or her apparatus, and with the Incident Commander who must orchestrate the entire operation.

A Rule of Thumb for Placement

There are many details that may affect placement of fire apparatus. However, there is one rule of thumb that officers can use as a foundation from which to make their decisions. This rule of thumb is based on the primary functions of the engine and truck companies.

The first-in engine should be positioned at the front of the emergency. This allows them to start attacking the fire, plus gives the first-in officer a vantage point from which to establish the initial command post. The second-in engine should go to the rear of the emergency. By positioning engines front and rear, both crews can better protect all four sides of the building and nearby exposures. Both officers can also better assess the entire perimeter of the incident.

The first-in truck should be positioned at a point where aerial capabilities may be required. This is generally at the front of the emergency, but will depend on the conditions present. The truck may be needed for rescue, ventilation, or an aerial attack on the fire. The greatest need will pretty much dictate proper placement. (See Information Sheet #24.1 for additional information.)

Factors Affecting Placement

Once again, there are many factors that affect placement of both engines and trucks. The emergency itself is the biggest factor. What type of emergency is this? Placement will be different for a structure fire than for a wildland fire, a building collapse, an explosion, etc. How large is this emergency? The larger the incident, the more critical the placement of apparatus. Access to and from the site is another important factor. On narrow streets or in "urban interface" areas, positioning apparatus will be much more difficult. It may not be possible to get close enough for convenient operations. The fire officer also must take into account what is happening on all six "faces" of the incident: all four sides, the top, and the bottom. Is there a need to cover another location? Is there better access from another direction?

Very much related to both the type of incident and access is the issue of safety. Far too many response vehicles have been damaged or destroyed, and fire fighters killed or injured, when their drivers positioned them in an unsafe area. If there is a possibility of structural collapse, an explosion, rapid escalation of a fire or haz mat incident, or being overrun by fire (such as in an urban interface or wildland incident), apparatus must be positioned at a safe distance from the emergency and facing in the direction of escape. Even something as simple and commonplace as overhead electrical wires can significantly impact where and how apparatus is positioned.

Apparatus must be positioned in such a manner to best accomplish strategic goals and tactical priorities. Thus, placement of apparatus must be considered early in the size-up stage. When the fire officer is determining placement, he or she must consider the number, type and capability of apparatus responding. If resources are limited, the apparatus must be positioned for maximum flexibility. If there is plenty of equipment en route, flexibility is less of an issue. Other guidelines for apparatus placement may be found in department policies or prefire plans for specific facilities.

Additional Guidelines

Any facility considered a target hazard within the jurisdiction should be preplanned. That preplan should include apparatus placement. Although actual placement may vary depending on the conditions of the emergency, the benefit of addressing this in the preplanning stage is that decisions can be made in a calm environment. The fire officer can take some time to consider important factors such as potential hazards, access to the site, and access to fire protection equipment such as fire department connections.

It is important to avoid "trapping" units. The position of one unit should not block access routes or impede other arriving units. The placement of hoselines should be considered. If lines are laid after apparatus have arrived on-scene, they may be blocked in until the hose is picked up. If they must be available on-scene to take other emergency calls, this becomes a major concern.

Apparatus should be positioned in the general area of their tactical objectives to minimize the distance that fire fighters have to walk or carry equipment. Parking too far away will slow down the operations, plus tire out the fire fighters much faster.

The fire officer must remember that once units are positioned they tend to become anchored. They are no longer as mobile as they were before. This is particularly true of trucks. Trucks also require additional room when setting up for aerial operations. Apparatus should not be positioned and set up until the fire officer is sure of where he or she wants them located. The Incident Commander should provide basic directions to incoming company officers about positioning, but should not try to park the apparatus for them. The company officer and his or her driver should know the capabilities of their apparatus and will park accordingly.

The Incident Commander should not allow incoming units to remain unassigned for indefinite periods of time. They will have a tendency to find their own position and assignment. Unassigned units should be placed at a designated "staging area" at a convenient distance from the emergency. Apparatus should not be allowed to stack up or converge at the front of the emergency or command post area.

When personnel are needed, but not the apparatus, the staging area may be even further away. Such might be the case in a high rise incident where additional units are needed more for rotating line personnel, but where apparatus already on-scene is sufficient for suppression activities. If mutual aid companies will be coming in from other jurisdictions, it is extremely helpful to have a person physically guide to them to the staging area versus trying to give them directions by radio. If they are not familiar with the area, trying to direct them by radio may be confusing.

Finally, the Incident Commander must think about keeping apparatus in reserve as long as they may be needed. Staged units should not be released too early.

Summary

The positioning of apparatus is important to the success of any fireground operation. First and foremost, apparatus must be placed in a position where personnel will be safe from any potential hazards on the scene. Engines and trucks must be positioned where they can best accomplish the tactical objectives they have been assigned. This will vary depending on the incident, access to the area, and the resources available. Positioning cannot be haphazard. It must be carefully thought out by the Incident Commander and the driver/operators in charge of each vehicle.

Chapter Review Questions

1. Who is responsible for proper positioning of fire apparatus at an emergency?

2. What rule of thumb may be used in positioning the first-arriving units?

3. What are some of the key factors in positioning apparatus?

4. List some examples of safety concerns that dictate how to place apparatus.

5. What other guidelines should be following when positioning apparatus?

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6. What are the three operations that a truck company performs that impact placement?

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Leave Room for the Truck

by Joseph A. McNeece

Aerial ladders are raised at fires primarily to effect rescues, to ventilate and to provide a means for operating streams or advancing hoselines. Considering these three uses, we can set forth some methods and considerations for using the aerial on the fireground.

Save the front of the building for the aerial. Place pumping apparatus so that it does not obstruct access. You can stretch more hose, but you can't stretch more apparatus.

Rescue

A rescue via an aerial ladder is a serious task. There is no room for failure caused by inefficiency or poor judgment. Members of your department actually or potentially responsible for operations involving aerial ladders should know all that is to be known on the subject.

Whenever rescues are attempted by aerial ladders, the officer in charge of the apparatus is directly responsible. Sound, quick judgment and training is required because human life is in the balance and time is a pressing element. The fire fighters who are assigned to the "truck company" should be alert in anticipation of aerial ladder work. Driver operators should listen and communicate with the officer in charge as to what action is to be taken and advise whether it can be done. Driver operators are responsible for proper positioning with a minimum of maneuvering. The aim is the successful accomplishment of the rescue. Other factors to consider when positioning the truck are number of stories, occupancy, set backs, long and short frontage, and obvious rescue (victims at windows, etc.).

Ventilation

When placing the aerial for ventilation, remember that it may be the only means of escape for the ventilation team. If conditions become untenable and dangerous, the aerial must be where they left it. Always place the ladder 4 to 5 rungs over the edge so that it can be located. Paint the tip! The truck officer may consider the use of adjoining buildings if possible for ventilation work.

Streams

The use of the master stream device indicates a need for access to more than one point in the building. Place the truck on a corner to allow use on at least two sides. What is easier: advancing hose up and down hallways and stairs or up an aerial ladder? The initial hoseline may be advanced via the interior of the building, but consideration should be made to take a second line via the aerial ladder.

Summary

The truck company is a specialized piece of equipment; use it to its full potential. How can you find out this potential? The answer is multiple company training: engine and truck. It's very important that you anticipate the use of the truck company at all fires. It's not an expensive taxicab.

Remember, position is very important. So, leave room for the truck!

Reference: WNYF Magazine, New York City Fire Department, Truck Company Fireground Operation - Richman.

Topic 25: Initial Attack

The actions taken in the early stages of the fire have a significant impact on the rest of the incident. The fire officer must be familiar with basic guidelines for a successful initial attack. This includes a knowledge of primary hazards one can expect to find in different types of occupancies.

Basic Rules of Initial Attack

The following information is based on an article entitled *"Improve Initial Fire Attack by Following Basic Rules"* written by Dick Sylvia. It was published in the July 1975 issue of Fire Engineering by the Dun-Donnelley Publishing Corporation.

Life Safety Dictates the Placement of the First Hoseline

Life safety is always the first consideration at any fire. This includes the safety of both fire fighters and civilians. If building occupants are trapped, the first hoseline becomes an integral part of the rescue effort. It may be needed not only to protect both victims and fire fighters from the fire, heat, and smoke, but also to mark the escape route for rescue team. The deployment of hoselines must be done in conjunction with ventilation efforts.

Keep the First Hoseline between the Fire and the Building Occupants

By keeping the hoseline between the fire and building occupants, fire fighters can slow or stop the advance of fire. That buys additional time to safely get occupants out of the building.

Control the Stairways

Every effort should be made to control the stairs within a building. The stairs are a vital link in a fire emergency. They are the primary means of egress for building occupants on upper floors or in basements. Elevators cannot be safely used. If the stairwells are lost, fire fighters may have to depend on more extreme measures such as taking people down ladders, or in rare cases using helicopters for rooftop evacuations. Both are extremely slow by comparison, and require extensive personnel and equipment resources.

The stairs also provide the most efficient means for getting personnel and equipment to the fire floor and back down again. Once again, the use of ladders becomes more cumbersome.

Finally, stairwells provide a vertical path for fire extension. Convected heat can carry the fire to floors a considerable distance from the point of origin. This is more of a problem in dwellings or other buildings with unenclosed stairwells. However, it can also be a concern with enclosed stairwells if any of the doors have been left open.

If Fire Is Burning Out a Building, Keep It Moving in the Same Direction

With a free burning fire that has already vented itself, the easiest and quickest way to extinguish the fire is to use hoselines to push it out the building in the same direction. Trying to force it back in the opposite direction is slow and difficult. It will most likely push the fire toward uninvolved areas of the building. Pushing the fire out the building must be done carefully, however, to avoid endangering exposures.

Provide Vertical and/or Horizontal Ventilation as Appropriate

Whether vertical or horizontal ventilation is most appropriate will depend on the type of structure and the condition and location of the fire. A small fire in one room of a house may be adequately ventilated just by opening the windows. A larger fire or a fire in the attic will require cutting a hole in the roof. The fire officer must be able to determine how to best remove smoke and heat, while at the same time minimizing damage to the structure.

When a Hoseline Is Not Advancing, Determine Why, Then Do Something about It

Interior attacks depend on being able to advance a hoseline to the seat of the fire. If a hoseline is stalled, the fire will continue to consume the building. There is no such thing as a standoff in a fire.

There are a number of things that may stop or slow an advancing hoseline. It may be the result of fire scene conditions such as excessive heat and smoke. In that case, increased ventilation may be necessary before fire fighters can progress further. Or, it may be related to limitations of fireground operations or equipment. The hoseline may be too short, too heavy to be manipulated around corners and other obstructions by the personnel currently available, or not large enough to provide the required fire flow. The hose may be tangled somewhere. The engineer may be having trouble delivering the required volume or pressure. Whatever the cause, fire fighters must determine the problem and do what it takes to keep the line advancing.

Use the Appropriate Size Hoseline from the Beginning

It is seldom going to be appropriate to start small and work up. A large hose stream applied immediately to a working fire will be far more effective than a small line that cannot keep up with the fire's growth. It will also be much safer for fire fighters.

If resources are limited, however, it may be necessary to start with smaller hoselines. A good example is a working structure in a remote area with limited water supplies and an extended response time for additional units. It can be more dangerous to fire fighters on the line if the tank is emptied before additional water becomes available. They could suddenly find themselves too close to the fire with no protection.

Extinguishing the Fire Can Minimize Other Problems

Normally rescue and exposure protection are higher priorities than fire extinguishment. But, sometimes extinguishing the fire can minimize other problems. For example, a fire in a high life-hazard occupancy such as a hospital or nursing home can present a serious rescue problem. Extinguishing the fire quickly can eliminate the need for rescue, or at least buy additional time to safely relocate patients to uninvolved areas of the building. Quickly extinguishing a fire where other exposures are threatened eliminates the need for exposure protection.

Summary

A successful initial attack can make a significant impact on the overall operations at an incident. The fire officer must understand where to place the first hoseline for the greatest protection of life and property, and must be able to choose the appropriate size hoseline both for effectiveness and for safety of the fire fighters. He or she must also recognize how actions taken in the first few minutes affect activities that may be required later.

Chapter Review Questions

1. What dictates the placement of the first hoseline?

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2. List three reasons why it is important to control stairways.

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3. What guidelines should be used to determine which direction to push a fire?

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   ____

4. What things may slow or stop an advancing hoseline?

   ____

   ____

   ____

5. What guidelines should be used to determine the appropriate size hoseline(s) to start with?

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   ____

Considerations for Initial Fire Attack

The following information is adapted from the National Fire Academy's student manual for Incident Command. It provides an overview of primary hazards found in different types of occupancies, as well as key fire fighting guidelines for initial attack.

Residential Occupancies		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Open stairways or stairways blocked open. • Lack of proper exiting. • Fast fire spread in wood frame building. • Buildings too close together. • Adjoining automobile garages. • Large framed attic areas. • Balloon construction in older homes (approximately pre-1915). • Wood shingle roofs or siding. • Electrical systems. • Elevators.	• Decorative material. • Carpeting. • Furniture and clothing. • Vehicles and stored fuel in garage. • Trash and combustibles (like paints).	• Rescue occupants. • Place a line between the occupants and the fire. • Support automatic systems. • Move an interior attack line (1½" or 1¾") with a fog nozzle to the seat of the fire. • Gain control of stairways. • Prevent vertical and horizontal spread. • Ventilate. Usually horizontal venting will do. • Check for attic fire and other hidden fire.
A single-family house fire can usually be considered no more than a 250-gpm fire. A first alarm assignment should be able to handle the fire. It should only be necessary for one engine to pump. The second-in engine can be left free to respond to other alarms. There is probably little need to have two engines pumping at a house fire unless a relay is needed.		

Places Of Assembly (Churches, Halls, Theaters)		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Exit problems (blocked, poorly marked or insufficient). • Fast fire spread if a wood frame building. • Large undivided areas in the building. • Exhaust ducting systems for cooking operations. • Ducting for heating and ventilation. • Lightweight or unstable roofs.	• Decorative materials. • Furnishings. • Drapes and curtains.	• Get people out. • Get a line between the occupants and the fire. • Mount a fast attack on the seat of the fire. • Open the exits. • Ventilate. • Support the automatic systems. • Use large hand line (2½") or monitors to control a spreading fire in a large undivided area

		with high ceilings.
Stores (Small Or Large Shopping Centers And Malls)		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Common attics and hanging ceilings. • Balconies and lofts. • Basements. • Lightweight or unstable roofs. • Large undivided areas. • Fire separations that have been pierced. • Fire doors blocked open. • Rear doors heavily secured. • Air handling systems.	Hazard Class: Moderate • Various chemicals in large quantities (pharmaceutical drugs, pesticides, dry pool chlorine, acids, paint thinners, barbecue lighter fluid, solvents, paints). • Aerosol containers. • Large amounts of clothing. • Large amounts of plastic products. • Rack storage of combustibles. • Trash and boxes in storerooms.	• Get the people out. • Support the automatic fire protection systems. • Stop horizontal and vertical spread. • Ventilate. • Get hand lines to the seat of the fire. • Get lines into the adjoining occupancies. • Use master streams if the fire is beyond the ability of hand lines. • Be aware of high levels of toxicity from combustion of various products, and of possible exploding pressurized containers. • Be alert for flashover in large retail sales areas.

Office Buildings		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Open stairways. • Elevators (passenger and cargo types). • Basement storage areas. • False facades on front of building, and framed out areas resulting from remodeling of old buildings. • Lack of adequate exits. • Air handling systems. • Lightweight or unstable roofs.	• Furnishings. • Carpets and drapes. • Valuable records. • Paper products and record storage.	• Get occupants out. • Support the automatic fire protection systems. • Make a fast attack with an interior hand line to the seat of the fire. • Gain control of stairways and vertical shafts. • Stop vertical and horizontal spread. • Ventilate. • Remove or protect business records. • Be aware of construction faults in the building.

Institutions (School, Hospital, Nursing Home, Jail)		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Fire doors blocked open. • Open stairways. • Locked doors in jails. • Hospital patient room doors blocked open. • Air handling systems. • Heavy facades and "gingerbread" decorations on fronts of buildings. • Elevators and vertical shafts. • Roofs and floors of heavy timber or concrete construction (hard to ventilate).	<u>Hazard Class: Low</u> • Life hazard: nonambulatory. • Oxygen or anesthetic gas system hazards. • Sterilizing equipment fire hazards. • School records. • Linen and supply rooms. • Heating and electrical systems in older buildings. • Mattresses and furniture.	• Remove occupants from building or ensure their safety. • Be sure exits are unlocked and unblocked. • Isolate the fire by closing fire separation doors. • Support the automatic fire protection systems. • Get lines between the fire and occupants. Usually 1½" or 1¾" lines will suffice. • Ventilate. • Stop horizontal/vertical spread. • Remove/protect valuable records.
Industrial Occupancies (Factories, Warehouses, Grain Elevators)		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Lightweight or unstable roofs. • Truss construction. • Fire walls with unprotected openings. • Fire doors blocked open. • Large undivided areas. • Heavy machinery on upper floors causing excessive weight and vibration. • Metal buildings having no fire resistance. • Grease pits, mechanic's pits, and sumps. • Cargo elevators with open shafts. • Open stairways. • Balconies and lofts. • Conveyor systems piercing fire walls. • Absence of fire separation between offices and factory area.	<u>Hazard Class: Varies but is generally moderate to high.</u> • Stock or other contents that can absorb water, expand, and push out walls, overload floors, or cause collapse and obstruct fire fighting. • Chemicals and hazardous materials. • Rack storage and high piled stock. • Dust and finely divided particles that can cause dust explosion. • Process hazards.	• Support fire protection systems. • Take interior hand lines to seat of the fire. Small fire, use 1½" or 1¾" lines. Medium involvement or fast moving fire, use 2½" lines. • Cut off vertical and horizontal fire spread. • Ventilate to channel the fire and clear the atmosphere. • Use portable monitors in areas of heavy/extensive involvement or untenable locations. Reinforce with more lines if your position is strategic and successful. • Resort to exterior master streams if defensive operation indicated. • Be alert for falling stock, failure of metal racks, etc. • Be alert to signs of potential building collapse or overloading of floors and roofs. • Prevent dust explosions. Use fog streams to avoid stirring up and dislodging dust or finely

		divided particles.
Fuel Facilities (Gas, Petroleum, Gasoline Storage)		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Pressure vessels. • Piping. • Liquid tanks. • Cylinders. • Metal building. • Loading docks.	Hazard Class: High to Extreme • Petroleum products (gas and liquid) • Hazardous chemicals.	• Evacuate exposed humans. • Cool exposed containers with heavy fog streams (2½" or master stream). • Shut off source of fuel supply. • Use heavy fog streams on the main body of the fire and the involved containers from a safe location. Use the monitors or remotely controlled elevated nozzles. Keep the fire fighters in a safe location and off aerial ladders or platforms due to the potential of explosion occurring at a major fire. • Use light water or other foam product to extinguish the fire. • Flush, direct and contain the flow of spilled product. • Plug leaks if possible.

Construction Sites		
Primary Construction Hazards	Primary Content Hazards	Key Fire Fighting Methods
• Exposed, unprotected construction members. • No usable fire protection systems. • Danger of early collapse. • Fast fire spread in wood construction with large amount of flames and heat. • Access to upper floors limited by lack of completed stairways. • Quick horizontal and vertical spread and quick involvement of exposures.	• No content hazards.	• Apply heavy fog streams to cool exposures and darken the fire. • Be aware of potential collapse. Stay out of, and away from structures. Be careful where apparatus are spotted so they are not overrun by fire. • Treat the fire as a lumberyard fire if in wood construction.

As a summary, it might be helpful if one could associate key words with the occupancy type and hazard presented. The following chart offers such an association pattern. It is not complete in and of itself, but may help trigger other responses.

Occupancy	Load	Content Hazard Class
Residential	Life	Low
Assembly	Life	Low
Store	Stock	Moderate
Office	Records	Low
Institutions	Nonambulatory	Low
Industrial	Chemicals	Moderate to High
Fuel Facility	Explosion	High to Extreme
New Construction	Collapse	High

Topic 26: Management Overview

The fire officer fulfills numerous roles in his or her job, and is charged with widely diverse responsibilities. In any duty cycle, he or she may be required to assume a dozen different roles including Incident Commander, company member, or fire prevention inspector. Regardless of the role, the company officer is the first level of management within the department and must have an understanding of the responsibilities associated therein.

The term "management" is often used with little thought given to the actual meaning of the word. Management can be defined as the "technique of either accomplishing work or obtaining results through people." For example, in the process of extinguishing a structure fire, battalion chiefs provide direction to individual captains, who in turn direct the activities of the fire fighters.

This chapter provides an overview to the concept of management as a whole. Specific principles and practices of management are discussed in later chapters.

Management Concepts

To properly fulfill his or her role as a manager, the fire officer must understand the basic concepts of management. There are numerous different management concepts. However, five are of particular importance to the fire officer:

1. A manager must work with and through other people. Managers cannot do everything themselves. They must rely on others.
2. Managers are often less "hands on" oriented than the people they supervise. However, their strengths are in managing resources (people) and the project as a whole. They are responsible for how their team's efforts fit into the "bigger picture." They are more concerned with the overall goal rather than the individual details required to accomplish the goal. "Hands on" involvement is delegated to their crews.
3. Managers are often more comfortable performing manipulative tasks rather than managerial functions. They may feel that it is easier to do something themselves than to assign the task to others. They may get immediate results that way. The task is done the way they want it done. Some managers do not feel comfortable delegating too many tasks for fear that their employees may resent it. However, managers must guard against getting too deeply involved with "hands on" activities or supervision will suffer. This is often referred to as "reverting to the tailboard."
4. The higher the level of managerial responsibility, the less important manipulative skills become in obtaining objectives. The Incident Commander does not have to be the best fire fighter in the department to successfully direct fire scene operations. A company officer does not have to be as proficient at operating a pump as his or her engineer.

   NFPA recommends that the fire officer have acquired skills equivalent to a certified Fire Fighter II. However, staffing levels in the department often dictate the required level of technical expertise. The company officer in a two-person engine company is going to end up on the nozzle of a hoseline. He or she requires the technical expertise to fulfill that role.

5. If objectives are to be met effectively, then managers must manage. When management is lacking, confusion and inefficiency are often the result.

Functions of Management

Management consists of four basic functions: planning, organizing, leading, and controlling. Planning at an emergency scene involves sizing up the situation, and anticipating both potential problems that may occur and the resources needed to mitigate the situation. Under nonemergency conditions, planning requires analyzing the needs of the department and developing a plan to address those needs.

Organizing involves coordinating resources and activities for the accomplishment of a common goal. Leading goes beyond just directing the efforts of others, though that is certainly part of it. Leading often means taking action that sets an example for other folks. Controlling encompasses measuring and regulating results.

Table 26.1 provides some examples of these four functions both at emergency scenes and for more routine department activities.

Table 26.1: Examples of Management Functions

Function	Emergency Scene	Nonemergency Conditions
Planning	Conducting a size-up.	Making up a duty roster.
Organizing	Creating divisions.	Assigning work crews.
Leading	Setting objectives.	Providing guidelines to work crews.
Controlling	Allotting resources, soliciting progress reports.	Conducting performance evaluations.

Fire command is largely a management exercise. Although the activities are unique to the fire service, management skills are not. Any manager in any field accomplishes work or obtains results by directing the activities of others.

Summary

In order to properly fulfill his or her role as a manager, the fire officer must understand the basic concepts of management. A manager must work with and through other people. Managers are often less technically oriented than the people they supervise. They may sometimes be more comfortable performing technical skills than managerial ones. However, if objectives are to be met, managers must manage. Management consists for four basic functions: planning, organizing, leading, and controlling. Each has applications both on and off the fireground.

Chapter Review Questions

1. What does the term "management" mean?

2. What are the five basic management concepts that are of particular importance to the fire officer?

3. What level of acquired (fire fighter) skills does the NFPA recommend that a fire officer possess?

4. List the four different management functions and give an example of each.

Topic 27: The Fire Service

Each individual fire fighter or fire officer is an integral part of the larger organization known as the fire service. It is important to understand the goals of this organization, the problems facing the fire service today, and how the fire service can effectively respond to these problems.

The fire service is a loosely aligned entity consisting of approximately 30,000 separate fire protection agencies ranging from larger paid departments to small rural districts. Most of these agencies are relatively small. It is estimated that there are at least 200,000 career personnel and more than a million on-call or volunteer personnel serving in the United States.

All fire departments have the same goal - the protection of life and property. While the focus is often on protection from unwanted fire, most departments provide many other services as well. Many fire departments throughout the country provide emergency medical services (EMS). In fact, fire fighters often respond to twice as many EMS calls as they do fire alarms. A growing number of departments also respond to hazardous materials incidents.

Problems Facing the Fire Service

Most fire departments are operated as singular or separate entities. They are managed independently. Decisions and policies are implemented on a local level. However, most departments not only have a common goal, they are facing common problems. Some of these problems include:

- Diminished revenues and funding, compounded by inflation
- Increased demands for service
- Continued apathy and indifference of the public towards fire prevention
- Increasing number of arson fires
- Greater hazards from exposure to products of combustion and hazardous materials
- Increased growth in the community
- Changing work ethic of newer employees
- Changing hiring practices to ensure equal opportunity
- Increased social, logistical and equipment issues with the influx of women fire fighters
- Greater influence of labor organizations
- Growth of private fire protection agencies

The fire service has traditionally faced such problems individually, each department seeking its own answers and solutions, each problem viewed as a single entity unrelated to the others. More effective problem solving techniques can be found by utilizing a "systems approach" such as is commonly used in business.

The Systems Approach

The systems approach is a method of looking at the total picture to see how the various elements are interconnected. It identifies both the overall problem and the individual components that contribute to it. It recognizes that each component affects several others. NASA's problem of putting a man on the moon is an excellent example. It required massive planning and coordination efforts. The project required ten years and ten billion dollars to complete. Many different resources from all over the country were involved in the overall project. Though their roles and contributions were very different, their efforts were directed toward one common goal.

The systems approach is the preferred method of problem solving. It has two major advantages. First, the synergy that results from pooling resources with other persons or other departments often leads to solutions that are far more effective. Second, by looking at the overall problem it is possible to develop solutions that positively affect other components - or at least do not negatively affect them.

The fire service can also benefit from the systems approach. The key is to identify overall goals, recognize that all problems consist of numerous components, and recognize that all resources and activities are related.

Summary

There are a number of problems facing the fire service today. The best method for resolving those problems is to take systems approach that looks both at the overall problem and the individual components that contribute to it.

Chapter Review Questions

1. What is the overall goal common to all fire departments?

   ____

   ____

   ____

   ____

2. What are some of the problems common to all fire departments?

   ____

   ____

   ____

   ____

   ____

3. What is the major premise of the systems approach to problem solving?

4. What are the major advantages associated with the systems approach to problem solving?

Activity 27-1

TITLE:	The Systems Approach
INTRODUCTION:	The purpose of this exercise is to take a closer look at how the systems approach to problem solving applies to the fire service.
DIRECTIONS:	1. Within your group, decide on a problem facing your fire department or the fire service in general. 2. You may choose from the list at the beginning of this topic or come up with your own example. 3. Take the next 20 minutes to discuss the following questions among the members of the group. 4. Be prepared to discuss your answers with the class.

1. What is the overall problem?

2. What are some of the individual components within this overall problem?

3. What are some of the solutions your departments have implemented thus far?

4. How did these solutions affect other components? Was the impact positive or negative?

5. Did these solutions solve the overall problem?

Topic 28: The Company Officer

If company officers are to fulfill the role of fireground commanders, they must posses certain skills, knowledge, and abilities. They must be able to draw from experience, building on the positive ones and avoiding repeating mistakes from the negative ones. Further, they must recognize the managerial obligations of the command position. This is true regardless of the size of department or individual company, whether the department is paid or volunteer, or years of service within the department.

Skills, Knowledge, and Abilities Required

This section provides just a general overview of required skills, knowledge, and abilities. Complete, detailed requirements can be found in various references such as local agency job descriptions, NFPA #1201, and state training or certification standards.

Skills

Skills are the recognized abilities acquired or developed through experience. The fire officer must be proficient in the use of tools to the level of a Certified Fire Fighter I and II. Although he or she will focus more on managing people and activities as opposed to getting involved in the actual "hands-on" activities, the fire officers in many departments with limited staffing work side by side with their crews. Even those who do not must be sufficiently familiar with the skills required of their fire fighters to properly direct their efforts.

There are some skills that are universal throughout the fire service: fire suppression techniques, operation of fire apparatus and equipment, emergency medical services, and hazardous materials control and mitigation techniques. The fire officer may also need to be proficient at wildland fire fighting, heavy rescue techniques, aircraft crash rescue and fire suppression, working with special apparatus and equipment, etc. as appropriate to his or her jurisdiction.

Knowledge

Once again, fire officers must be knowledgeable about topics specific to the fire service: fire chemistry and behavior, fire control measures, extinguishing agents, fireground safety, size-up procedures, and tactics and strategy. They must be familiar with local building design, construction and codes; target hazards within their jurisdiction; department policies and procedures; and resources available within the community, including mutual aid agreements. They must also be acquainted with basic supervision and management skills, characteristics of human behavior and team building techniques.

Abilities

An ability is the power, mental or physical, to accomplish something, and usually implies doing it well. The fire officer must be able to conduct a proper size-up, solve problems, and make decisions, usually under considerable pressure. Other necessary abilities are common to any management position: the ability to delegate; to instill confidence in others (especially other crew members); to communicate, listen and accept new ideas and concepts; to motivate others; to train others, and share knowledge and experience; and to manage people and activities.

Managerial Obligations

Detailed descriptions of managerial obligations are available within various documents developed by your department. They may include standard operating procedures (SOPs), rules and regulations manuals, operational memorandums, general and special orders, and mission or value statements.

These obligations can be categorized into two classifications: organizational management and emergency scene management. These are both closely related. Success at fulfilling one will have a positive effect on the others. Conversely, failure to address one responsibility can have negative effects upon others. If, for example, the fire officer fails to provide proper leadership and direction within the organization, his or her crew may have difficulty working as an efficient team on the fireground. On the other hand, a fire officer who looks out for the safety of his or her crew on the fireground, and makes sound decisions under pressure, will earn more respect and loyalty that will reap benefits off the fireground as well.

Table #28.1 highlights some of the key obligations in both categories as they apply to various entities. You may have others to add to this list.

Table #28.1 Managerial Obligations

Entity	Organizational Management	Emergency Scene Management
The Public	Ensure efficiency in all programs and activities.	Eliminate pending or future threats to life and property. Reduce and control the impact of emergencies as quickly as possible.
The Department	Attain declared missions and goals. Adhere to standard operating procedures. Develop and deliver programs.	Adhere to emergency plans, disaster preparedness, and standard operating procedures. Utilize resources as efficiently as possible. Integrate your actions and resources to the department's overall efforts.
Your Crew	Provide leadership and direction. Develop a positive working environment. Develop individual and group skills.	Look out for their safety. Assign objectives. Provide leadership and direction.
Yourself	• Reinforce both your knowledge and experiences; continue to learn. • Remain mentally and physically fit.	• Place yourself in a managerial position as soon as possible. • Recognize the effects of stress and implement appropriate coping mechanisms.

Summary

The fire officer must possess certain skills, knowledge, and abilities. Some are specific to the fire service. Others apply to managers in any profession. The fire officer must also be familiar with the specific managerial objectives that apply to organizational management and emergency scene management.

Chapter Review Questions

1. Where can a fire officer find complete, detailed requirements regarding skills, knowledge, and experience?

   ____

   ____

2. What is the difference between skills and abilities?

   ____

   ____

3. What are some of the skills that a fire officer must possess?

   ____

   ____

4. What topics must the fire officer be knowledgeable about?

   ____

   ____

5. What are some of the abilities that a fire officer must possess?

   ____

   ____

6. What are some of the key managerial objectives for a fire officer?

   ____

   ____

Activity 28-1

TITLE: Development of Specialty Areas

DIRECTIONS:

1. Break into groups of 3 to 4 people.
2. Within your group, develop a list of specialty areas that a fire officer may evolve into during his or her career.
3. Indicate the skills that are involved in the development of these specialty areas. A number of these skills will be further developed throughout your career.
4. Be prepared to discuss your answers with the class.

Specialty Areas	Skills Required

Activity 28-2

TITLE:	Skills, Knowledge, and Abilities
INTRODUCTION:	Periodic self-assessment will assist any fire officer in determining areas that may require personal development.
DIRECTIONS:	1. Identify your personal strengths and weaknesses in the areas of skills, knowledge, and abilities. This is your personal assessment. You do not need to share them with anyone else.

Area	Strengths	Weaknesses
Skills		
Knowledge		
Abilities		

Topic 29: Pressure of Command

All personnel involved in an emergency will experience some degree of anxiety or stress. The fireground commander is especially prone to this. The stress associated with command functions can have an adverse effect upon the commander's performance. Therefore, it is extremely important for the fire officer to understand what causes stress, the effects it can have on people, and techniques to minimize that stress.

Stress

Stress is essentially an adjustment to change. Stress may be categorized as good stress (eustress) or bad stress (distress). We are primarily concerned with distress in the fire service.

Stress is a normal reaction to change or excessive demands on the mind or body. It is unavoidable. Stress can be of some benefit to fire fighters. It can create a heightened awareness of the situation. Stress can also enable fire fighters to perform more quickly and efficiently, both mentally and physically. However, when stress builds to a level at which fire fighters can no longer cope effectively, it becomes distress. The body becomes mentally and/or physically exhausted, and unable to supply the energy needed to continue functioning at those higher levels.

Stress can be acute or chronic. Acute stress is short term, brought on primarily by a specific incident or event. When the stressful stimulus is removed, the stress usually disappears as well. Chronic stress is of longer duration, and may be the result of numerous stimuli from different sources. The individual may feel helpless to deal with the overwhelming pressures that just will not go away. This chronic stress is most often linked to health problems such as heart disease, ulcers, migraines, insomnia, and even cancer.

A variety of stimuli can trigger stress. Fire fighters, of course, are subject to the same stressors as any other human being: fear, anger, exhaustion, frustration, excessive demands, etc. They may be due to problems at work such as conflicts with other personnel, inadequate station conditions, or lack of recognition and appreciation. Or, they may be due to situations off the job such as relationship problems, health problems in the family, financial difficulties, or problems with the house and/or car.

Yet, fire fighters are subject to other stressors that the public seldom experiences, the most intense of which is responding to emergencies where life and property are endangered, and where sometimes the fire fighter faces enormous risks to his or her personal safety. The pressure of having to "call the shots" when lives and property are at stake intensifies the stress faced by the fire officer. Fire fighters are also subjected to excessive physical demands: fire suppression activities, extremes of heat and cold, exposure to hazardous atmospheres, high noise levels, and abrupt interruption of meals and sleep. Table 29.1 lists various different fireground stress factors to which fire officers may be exposed.

Table 29.1: Fireground Stress Factors

Fear of	Danger
• Personal injury • Injury to subordinates • Known hazards • The unknown • Making a mistake	• Search and rescue operations • Excessive fire • Exposure to hazardous materials • Potential for structure collapse • Being above a brush fire
Environmental Stressors	**Being Overwhelmed**
• Temperature extremes • Excessive noise • Humidity • Altitude • Working in tight quarters	• Being first in on a major incident • Lack of resources (personnel or equipment) • Being beyond your span of control • Situations beyond your training • Bad call - Everything goes wrong
Physical Discomfort	**Difficult Decisions**
• Protective equipment that doesn't fit properly • Injury or illness • Inadequate or interrupted sleep • Exhaustion (mental or physical) • Overexertion • Hunger or thirst • Having to relieve oneself	• Sending fire fighters into an extremely dangerous situation • Mass casualty incidents requiring triage • Knowing a rescue situation is imminent • Having to make decisions based on unknowns or insufficient information
Communications Problems	**Personal Doubts**
• No contact on the radio • Poor radio transmissions • Excessive radio traffic • Incompatible frequencies with mutual aid companies • Excessive noise making hearing difficult	• Lack of confidence • Lack of experience • Inadequate time to prepare • Not knowing what is going on • Inability to "let go" of a mistake • New captain not accustomed to command
Fireground Problems	**Frustration**
• Deterioration of the incident or the victim • Lack of water, pressure or flow • Hydrant not located where shown on maps • Sudden change in the call • Unexpected circumstances • "Murphy's Law"	• Job not being done properly • Objectives not being met • Assignment not up to your expectations • Not getting adequate information • Confusion • Lack of recall information/drawing a blank • Not being able to use the tools you have

<table>
<tr><th>Other Mental Distractions</th><th>People Problems</th></tr>
<tr><td>Getting personally involved in the incident
Distracted by problems at home
Overconfidence, pride</td><td>Having someone lose control
Excited peers or dispatchers
Inadequate information from dispatchers
Over supervision
Negative interaction with the public or media</td></tr>
</table>

Activity 29-1

TITLE:	Your Most Stressful Experiences
DIRECTIONS:	1. List 5 or 6 emergency personal experiences that you considered to be the most distressing and traumatic. 2. Indicate how you dealt with each situation, and whether or not it effectively managed the stress. 3. Be prepared to discuss at least one of these experiences with the class.

1. Experience: ______________________________

   ____

   How I dealt with it:

   ____

   ____

   ____

   ____

   ____

2. Experience: ______________________________

   ____

   How I dealt with it:

   ____

   ____

   ____

   ____

   ____

3. Experience: ______________________________

____

How I dealt with it:

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4. Experience: ______________________________

____

How I dealt with it:

____

____

____

5. Experience: ______________________________

____

How I dealt with it:

____

____

____

6. Experience: ______________________________

____

How I dealt with it:

____

____

____

Response to Stress

Different people respond to stress in different ways. An individual's ability to cope, as well as the type, duration, and intensity of the stressor, all affect how that stress will manifest itself.

The body generally responds with increases in heart rate, blood pressure, and respiration. The senses become sharpened resulting in a heightened awareness of the problem and the environment. A person may also experience "butterflies" in the stomach, queasiness, or muscle tension.

Some of the more noticeable signs that stress may be building to dangerous levels include general irritability, emotional instability, inability to concentrate, fatigue, insomnia, or restless sleep, and either loss of appetite or overeating. Some people will even resort to using alcohol or drugs to escape the pressure.

The fire officer experiencing distress on the fireground may exhibit other behaviors:

- Abdication of responsibility.
  - He or she may be present in the command role, but not exercising any authority.
- Communication collapse, including issuing conflicting orders, failure to properly communicate information, or "hogging" radio time with trivial communications.
- Reverting to a level of comfort.
  - The fire officer may avoid management responsibilities and instead take on tasks that should be delegated to the fire fighters. He or she may become too involved with the "hands-on" activities.
- Tunnel vision.
  - He or she may lose sight of the "big picture," concentrating instead on a single objective without considering how it affects other activities.
- Dysfunctional behavior.
  - This may include expending effort and resources without a clear goal. The fire officer may be described as "running in circles."
- System overload.
  - If the pressure becomes too great, the fire officer may be unable to cope with the situation or the stress that he/she is feeling, and unable to function in a command role.

Coping with Stress

Coping with stress should take place on three levels: programs aimed at maintaining the health and well-being of personnel, coping mechanisms to assist the fire fighter or fire officer during the emergency, and programs such as Critical Incident Stress Debriefing to help the individual "de-stress." Fire fighters should also receive stress reduction training so that they are better able to recognize the symptoms and deal with stress before it becomes overwhelming.

Maintaining Health and Well-Being

As already discussed in the last chapter, a good physical fitness program which includes annual medical check-ups, cardiovascular exercise and weight control programs will help to reduce stress. Exercise, in particular, benefits not just the body but the mind as well. It can increase stamina and reduce an individual's "distress threshold." Many people also find exercise an excellent method to relieve stress in their daily lives.

It is also important to get adequate rest. Mental and physical exhaustion are often significant contributing factors when people are under stress. Adequate rest may mean just getting enough sleep, or it may require taking time to slow down and relax, or maybe take a vacation.

Maintaining the health and well being of fire fighters also includes the proper use of personal protective equipment to protect from environmental stressors. Fire fighters must be trained in the proper use of this equipment, and policies for its use should be strictly enforced.

Coping Mechanisms for the Fireground

You do not get to take vacations on the fireground, so there must be other mechanisms to cope with stress. The first is just to recognize that stress is a natural, unavoidable part of the job. The idea is to cope with it, not resist it. Take advantage of the benefits that stress can have: heightened awareness, and improved mental and physical performance.

Realize that you are not personally responsible for the emergency occurring. You did not start the fire. You did not cause the accident. The emergency has already occurred. Your goal is to prevent further loss of life and property. You are reducing the impact of the emergency, not making everything perfect, or returning the situation to its pre-emergency status.

Realize that the resources available will not always allow you to accomplish your objectives. Sometimes the most difficult skill an officer must learn is the ability to write off losses and go on. Just like the athlete who must shake off the mistake of a bad play and keep his or her head in the game, so must the fire officer. You must focus on the overall goal and do what it takes to get there.

Approach the command function with a systematic, objective frame of mind. Follow your training and the "basics" of fireground operations. Treat the emergency as a challenge requiring your managerial skills, not an overwhelming problem. Do not be afraid to ask for assistance from other officers. You may also wish to consider appointing an aide or assigning some of the responsibilities to a fire fighter in order to take some of the pressure off.

Be alert to signs of stress in yourself and others around you. Recognizing stress when it occurs is the first step to coping with it.

Critical Incident Stress Debriefing

Critical incident stress is a special kind of stress associated with particularly traumatic or disturbing incidents. The worst is a situation in which a fellow fire fighter is killed or injured. More commonly, fire fighters experience critical incident stress with mass casualty incidents or accidents where children are killed. Seeing someone suffer extreme pain or being helpless to save a life can often cause critical incident stress.

Symptoms of critical incident stress may occur at the scene of the incident, or they not appear for hours, days, weeks, or even months. Some of the more common symptoms at the scene include denial, anger, self-doubt, guilt, anxiety, frustration, and a sense of helplessness. These feelings may linger for some time after the incident. They may be compounded later by depression, restlessness, irritability, flashbacks, sleep disturbances, and changes in eating patterns. A person may also turn to alcohol or drugs to escape the pain.

Critical incident stress may severely affect a fire fighter's performance on the job, as well as his or her personal well-being. It cannot be ignored. Once again, training is an important tool for dealing with stress. Fire fighters must recognize that critical incident stress is a normal response to an overwhelming situation. They must be able to recognize the signs and symptoms, and must know what techniques and resources are available to cope with it.

Peer support is one method for coping with stress encountered on the job. No one else really understands what a fire fighter goes through as well as another fire fighter. Peer support may involve relatively informal discussion with one's coworkers or friends. Or, there may a formal peer support network within the department with personnel who have received special training in dealing with critical incident stress.

Critical incident stress debriefing is a more formal process led by specially trained mental health professionals. Debriefings should be held within a few days of the incident, and should be mandatory for personnel who were involved in the incident. It is an opportunity for fire fighters to share their feelings and to discuss how the incident may have affected their lives. As with peer support, these debriefings help the fire fighters to see that they are not alone and that others are experiencing similar feelings and problems. However, the mental health professionals are better trained to recognize feelings that fire fighters may not be in touch with or aware of. They are also more familiar with coping mechanisms. More in-depth individual counseling sessions may be needed when fire fighters are experiencing severe stress or excessive depression.

Critical incident stress debriefings are not a time to talk about tactics and strategies. It is a time for personnel to talk about how the incident has touched their lives. What are they feeling? How has the incident affected them emotionally? What physiological or psychological changes have they noticed, or have others noticed in them? What changes have they made in their lives since the event?

Maintaining a supportive atmosphere is a critical component of these debriefings. The information shared in the debriefing should be considered confidential unless otherwise specified. There should be no criticism or blame. Participants must feel that they can safely share their feelings or ask questions about what they are experiencing in order to get value out of the session. The debriefing should also include strategies for dealing with these feelings in the future. It is common for people to have occasional "bad days" when something reminds them of the incident and those uncomfortable emotions resurface. Those feelings do not just disappear forever because someone has attended a critical incident stress debriefing. The mental health professional(s) conducting the debriefing will generally suggest an action plan that fire fighters can implement individually or as a group in order to keep moving in a positive direction.

Command Presence

An intangible factor that can have a direct effect upon emergency scene activities is the "presence" or "bearing" of the officer in charge. Whether this effect will be positive or negative is largely decided by the officer's department.

The very word "emergency" implies a sense of urgency, a time of excitement and the threat of immediate danger. As fire fighters, we have committed ourselves to the reduction and control of these dangers. Our "workshop" is in the street, typically in an environment that everyone else has fled.

It is an exciting, demanding, and challenging task that requires cool, logical, competent behavior, especially of those in supervisory positions. An officer who "loses his or her cool," "overloads," or "goes bonkers" cannot operate efficiently. Additionally, emotional displays and/or irrational behavior will have a tendency to undermine everybody else's confidence and performance.

Remember… be like a duck. Above the surface, look composed and unruffled. Below the surface, paddle like

Summary

Stress is a normal response to change or excessive demands on the mind or body. Good stress can enable fire officers to perform more quickly and efficient. However, when stress builds to a level at which a person can no longer cope effectively, it becomes distress. The pressure of having to "call the shots" when lives and property are at stake intensifies the stress faced by the fire officer. It is extremely important for the fire officer to understand what causes stress, the effects it can have on people, and techniques to minimize that stress.

Chapter Review Questions

1. How can stress benefit a person?

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2. What is the difference between acute and chronic stress? Which is most harmful?

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3. List some of the things that can cause stress for the fire officer.

4. What are the signs/behaviors that may indicate that stress is building to a dangerous level?

5. What are some of the mechanisms for coping with stress?

6. What types of situations can cause critical incident stress?

7. What are some of the symptoms associated with critical incident stress?

8. What are some measures for dealing with critical incident stress?

Topic 30: Performance Standards

One of the most useful tools that the fire officer has at his or her disposal on the fireground is the performance standard. As the fire officer is sizing-up the situation and determining objectives, he or she must also consider how to deploy resources. Consider how difficult this would be if the fire officer was unfamiliar with the capabilities of the engine and truck companies within the department. How long would it take an engine company to lay a line or a truck company to ventilate a roof? This could add additional stress to the Incident Commander.

The Benefits of Performance Standards

Performance standards enable the fire officer to more accurately size-up the incident and determine the resources necessary to handle the problem. This gives the fire officer greater control over the basic resources; he or she is better able to assign objectives and anticipate how long it will take to accomplish them.

Performance standards are the minimum level of proficiency at which fire fighters are expected to perform. They increase proficiency within the department because everyone knows what they are expected to do, how well they are expected to do it, and the time frame they are expected to do it in. They also help to build both individual and team confidence.

At the same time, performance standards can identify potential problems. If the fire fighters are not able to safely and proficiently accomplish specific tasks in the time allotted, it may indicate a need for additional training, procedural changes, or equipment adjustments.

The Components of Performance Standards

Performance standards consist of the following three components:

Component	Description
Condition	The "condition" identifies the tools, work force, and equipment necessary to perform a task.
Behavior	"Behavior" identifies the specific action, job, or evolution that is to be accomplished.
Standard	"Standard" identifies how well the job is to be performed and the time frame it is to be accomplished in. It is a measure of quality.

The actual format of the performance standards may vary, but they must contain the three essential components. They must accurately reflect the capabilities of the department. They must also be designed with safety in mind. For example, if the task is to carry and raise a 35-foot extension ladder, it cannot safely be done by one person. However, it may be necessary to have two separate performance standards, one for a two-person evolution, and one for a three-person evolution. While three people are preferred for safety reasons, there are times when only two people will be available due to staffing levels.

It is important to recognize that although the performance standards often specify a time frame for accomplishing the task, this is not a race. The idea is not to see how quickly the task can be done. There is no value in performing a task so quickly that people make mistakes and get hurt. The time frame must be safe and reasonable. As the crews practice the various skills and improve their proficiency, they will naturally pick up speed.

Checklists for Scoring the Evolutions

Many performance evaluations will include a checklist for scoring the evolution that outlines the specific steps, with point values assigned to each. A perfect performance is worth 100 points. Points are deducted for each step missed or performed incorrectly.

Task Errors

With evolutions that are more complex, it may not be practical to have a detailed checklist that outlines every step. It may be more appropriate to identify task errors instead. A task error is any mistake which could affect the safety of personnel on-scene, including any citizens in the area, or which could substantially affect the outcome of the evolution within the acceptable time parameters.

Sample Performance Standards

The following are some different examples of performance standards:

Example #1

A simple performance standard for raising a 24-foot extension ladder:

Evolution: 24-Foot Extension Ladder

Condition: A fire apparatus with a full complement of ground ladders.

Behavior: The fire fighter will remove, carry, raise, lower, and return the 24-foot extension ladder to the apparatus.

Standard: The evolution is to be completed according to the department training manual within established safety guidelines and with 70% accuracy.

Example #2

A performance evaluation containing a list of task errors for a wildland progressive hose lay.

Evolution: Wildland Progressive Hose Lay (400 feet)

Condition: A three person engine company and simulated wildland fire.

Behavior: Spot fire engine at simulated anchor point.

Complete a 400-foot progressive hose lay utilizing a 200-foot preconnect and two 100-foot hose packs (one with a nozzle, one without).

Standard: The evolution is to be completed according to the department training manual, within a time frame of 5:00 minutes.

Task Errors: There will be a five second penalty for each of the following:

1. Failure to spot engine.
2. Failure to don all wildland safety gear.
3. Failure to place engine in pump and set at desired pump pressure.
4. Failure to don hose packs properly.
5. Failure to flow water while extending hose, extinguishing a simulated fire.
6. Failure to effectively work as a team.
7. Failure to use correct hose pack at first connection.
8. Failure to bleed hose off when applying hose clamp.

Example #3

A simple performance standard for donning SCBA, followed by a sample checklist for scoring the evolution.

Evolution: Don Self-Contained Breathing Apparatus

Condition: A positive pressure breathing apparatus.

Behavior: The fire fighter will demonstrate the proper procedure to don self-contained breathing apparatus.

Standard: The evolution is to be completed according to the department training manual with 85% accuracy. The time standard for this evolution is one minute. (Time begins when the compartment door is touched and ends when the unit is on and operating properly, and gloves are on.)

Performance Standard Checklist

Donning Self-Contained Breathing Apparatus

Name: ______________________________ Date: ____________

Step	Points Possible	Points Deducted
Remove face piece from compartment; take off helmet	5	
Check cylinder supply, open valve	10	
Don back-pack assembly	5	
Adjust straps	5	
Check valves for proper position	5	
Don mask	5	
Don Nomex hood	5	
Test mask	10	
Replace helmet	5	
Connect hose to regulator - Switch to "ON"	10	
Turn on personal alarm device	5	
Time (60) seconds	30	
(Deduct one point for each second over 60 seconds)		
Points Possible		100
Points Deducted		
Score		

Remarks: Collar up, gloves on. Time starts when compartment opens. Time stops when positive pressure switch is "ON."

Evaluator's Signature: ______________________________

Example #4

A more detailed performance standard for a fireground evolution, along with an illustration showing the location of the building, the hydrant, and the fire engine.

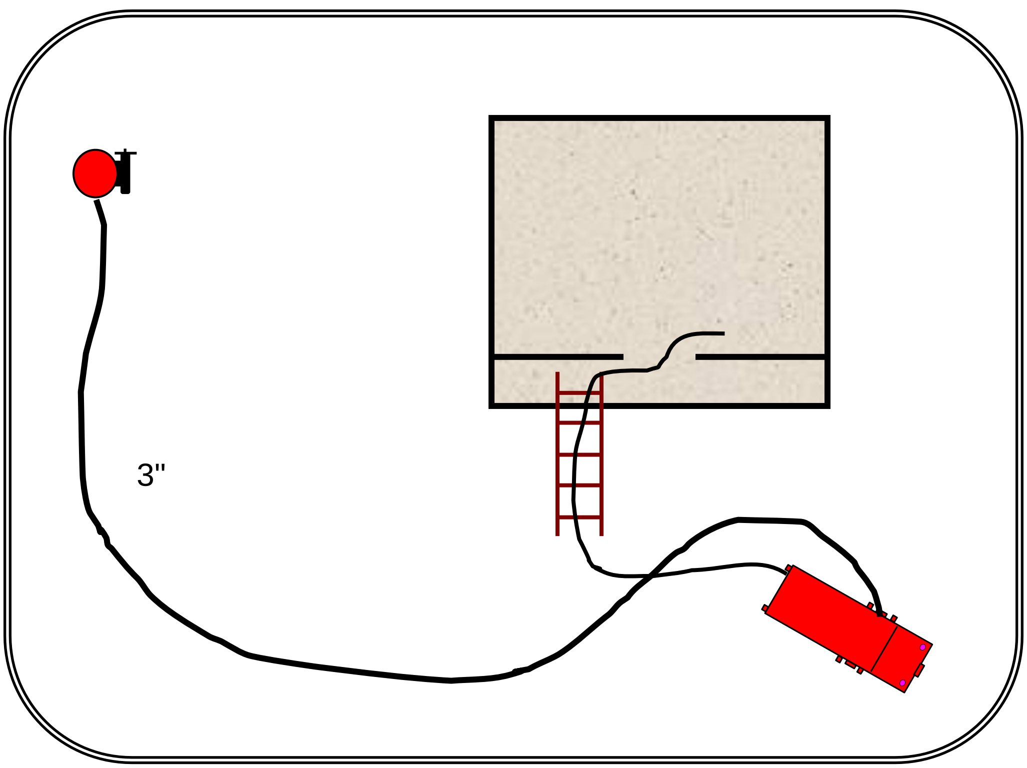
Evolution: Single Line In (Forward Lay); 1½" Line Aloft

Condition: A three-person engine company and a simulated building fire.

Behavior:

1. Lay a minimum of 100 feet of hose from the hydrant to the simulated building fire. (Place a hydrant gate valve on the hydrant.)
2. Ladder the building with a 24-foot extension ladder.
3. Company officer sizes up the incident.
4. Two fire fighters, wearing breathing apparatus and taking appropriate ventilation equipment, extend a 1½" preconnect line to the second floor via the 24-foot ground ladder. (This supply line is charged.)

Standard: The evolution is to be completed according to the department training manual, within established safety guidelines, and within 4:30 minutes. (An additional 30 seconds will be added for companies using 35-foot ground ladders.)



Factors Affecting Fireground Performance of Companies

Performance standards provide a guide that company officers can use to determine resource requirements. However, this is only a guide. Numerous factors can affect company performance. Some of these factors are beyond the control of the company officer.

Perhaps the most commonly overlooked factor is fatigue. Company officers cannot expect that their crews will function at 100% at all times. Fire fighting is exhausting work. If fire fighters have been working for an extended period of time, or if they responded from another call or the drill ground where they have been working hard already, they are likely to tire quickly. Fatigue can cause people to make judgment errors or manipulative mistakes, or even to overlook safety precautions. It is common practice to rotate personnel at 20 - 30 minute intervals when they are performing exhaustive work. The Incident Commander must consider this when requesting additional resources. Depleted staffing, whether for scheduling rest breaks or for any other reason, will cause a drop in performance.

Weather is another important factor. Extreme heat or cold, rain or high winds will affect operations. Fire fighters may become slower and more deliberate in their activities to avoid injury. Or, they may become uncomfortable enough that they do not pay close attention to proper procedures or safety precautions.

A third factor that makes a big difference is the nature of the emergency. Emergencies that fire fighters commonly encounter will probably produce steady, predictable efforts. The "once in a career" emergency is likely to increase initial company performance. Fire fighters respond to the "stress" of this new situation with a heightened awareness and increased mental and physical performance. Then eventually their performance will begin to level out. On the other hand, critical emergencies can have the opposite effect. If fire fighters are overwhelmed by the magnitude of the incident, they may no longer be able to cope effectively. Their performance will drop, and safety will become a major concern for the fire officer.

Summary

Performance standards are one of the most useful tools that the fire officer has at his or her disposal on the fireground. They enable the fire officer to more accurately size-up the incident and determine the resources necessary to handle the problem. They also increase proficiency within the department, help to build confidence, and can be used to identify potential problems. The fire officer must be familiar with the particular performance standards used within his or her department.

Chapter Review Questions

1. What are some of the benefits of performance standards?

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2. List and describe the three essential components of a performance standard.

Component	Description

3. What are some of things that must be considered when writing a performance standard for the department?

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4. What is a "task error?"

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5. What are some of the factors that can affect company performance?

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Activity 30-1

TITLE:	Performance Standards
INTRODUCTION:	The goal of this exercise is to give you practice in developing performance standards.
DIRECTIONS:	1. Your instructor will break you into small groups. 2. Review the information in this chapter concerning the components of a performance standard. 3. As a group, develop two different performance standards. The first should be a simple one containing only the "condition," "behavior," and "standard." The second should be a more complex company evolution containing a list of task errors. Refer to Examples #1 and #2 in the chapter. 4. Be prepared to discuss your answers with the class.

PERFORMANCE STANDARD #1

Evolution: ______________________________

Condition: ______________________________

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Behavior: ______________________________

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Standard: ______________________________

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PERFORMANCE STANDARD #2

Evolution: ______________________________

Condition: ______________________________

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Behavior: ______________________________

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Standard: ______________________________

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Task Errors: ______________________________

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Topic 31: Levels of Emergency

Nationwide, fire departments respond to millions of fires every year. Obviously, these fires are not all of the same size and intensity. Fire officers must be familiar with the various levels of emergency and how to best manage them.

Four Levels of Emergency

There are many different types of fires that a fire officer may respond to. They may be divided into four categories depending on size and complexity of operations required to fight that fire.

Nuisance Fire

The nuisance fire is just what it sounds like, a fire that is more of a nuisance than a danger. That is not to say that they cannot become dangerous. However, the amount of effort required to extinguish them is minimal. In fact, many of them can be handled by citizens with a fire extinguisher. Examples of nuisance fires include trash can fires, small grass fires such as in a median strip along the roadway, surface fires in a dumpster, etc.

Initial Attack

The initial attack fire is an incipient fire, or a free-burning fire confined to a relatively small area. It is usually handled by a single engine and does not require a full alarm assignment. Examples include fires confined to a closet, a small out building, or a single vehicle; a small grass fire; or a working dumpster fire.

Sustained Attack

A sustained attack fire is one that is often referred to as a "working" fire. This is a free-burning fire, one that has gone into the smoldering stage and now presents a backdraft hazard. It requires the full first alarm assignment. Examples include a working structure fire, large grass or brush fire, or flammable liquid spill that has ignited.

Campaign Fire

A campaign fire is a large, prolonged fire that is of such magnitude that it has become more of a defensive attack. It generally requires multiple alarms, and may need mutual aid assistance from other departments. Examples include fires where multiple structures and exposures are involved; large fires in a commercial, industrial or warehouse occupancy; working fires in a high rise building, hospital or other facility where there is a high life hazard potential; and major wildland fires, especially those in mountainous areas or those influenced by high winds.

Emergency Management/Command

Every fire, regardless of size, requires some elements of command. Yet, the degree and complexity of command varies with each level. On a nuisance or initial attack fire, the company officer may be both the Incident Commander and the nozzle person. On a sustained attack or major campaign fire, the first-in officer will begin by assuming Incident Command, but may end up filling other roles within the ICS structure once a senior officer arrives.

Common Errors

Most fire officers do not often have the opportunity to command a major fire. They usually serve as individual company officers supervising their own crews. This lack of experience can sometimes lead to errors such as delays in upgrading the alarm or summoning additional resources; inadequate deployment of resources such as personnel, apparatus, equipment or hoselines; or failure to exercise command.

The first-in officer has a unique opportunity to turn a potential disaster into a routine incident. Conversely, if a routine incident is not managed properly it can turn into a disaster. One thing that is essential in dealing with these different levels of emergency is to know when to request assistance. One rule of thumb that the fire officer can count on is that once he or she has mentally committed all existing resources it is time to order more. In other words, the fire officer should be requesting a second alarm as soon as it becomes obvious that all first alarm units will have an assignment, whether or not they are already on-scene.

It is beyond the scope of this course to address all the decisions that a fire officer will be faced with when commanding a major fire. To avoid some of these common errors, the officer must expand his or her knowledge of fireground operations and scene management. And, since experience at actual fires is generally limited, the fire officer should take advantage of classes, drills, and tabletop exercises that provide an opportunity to practice these skills.

Summary

There are four general categories of fire based on size and complexity of operations. Each requires some degree of command functions. The most difficult for any fire officer are the sustained attack or the campaign fire because of the multitude of details that must be handled and the pressures of being in command of an emergency that is beyond the resources of the first-in unit. The fire officer must be aware of the errors commonly made because of lack of experience, and must take advantage of various opportunities to practice the skills necessary to command a major incident.

Chapter Review Questions

1. Identify the four levels of emergency and give some examples of each.

2. What are some of the common errors made by the first-in officer on a major incident?

3. What is a good rule of thumb regarding the request for additional resources?

Topic 32: Decision Making

One of the most important skills that a fire officer must have is the ability to make decisions, particularly under the pressure of an emergency. He or she must be able to identify the problem, analyze the available information, weigh the alternatives based on valid criteria, and implement an appropriate solution. He or she must also be able to evaluate the results and adjust as needed. It is also important to realize that most decisions are not isolated acts; they very often affect other activities on the fireground.

The processes of size-up and determining the appropriate strategy, tactics, and methods were discussed in earlier chapters. This chapter focuses on the decision making process itself.

Identification of the Problem

Before any intelligent decision can be made, it is essential to identify the problem. Again, in the fire service this is known as size-up. The major difference between problem identification on the fireground and problem identification in the business world is that the fire officer does not have the luxury of studying the problem and mulling it over in detail. It has to happen right now. Yet, the fire officer must have a thorough understanding of the problem in order to determine an appropriate course of action. Imagine the results of rushing to make an interior attack on a structure fire only to discover, too late, that the burning contents included a highly volatile hazardous material.

With any problem, it is necessary to accurately define what the problem is, and to collect as much information as possible. Some of that information will come from personal observation. Other information will come from the reporting parties, on-site personnel, or other fire fighters sent to evaluate specific portions of the problem.

Evaluating the Alternatives and Their Possible Impacts

There are often several different ways to handle a problem. And, decisions are not necessarily linear; they do not always proceed logically in a straight line from one point to another. Sometimes a decision introduces new variables into the system that will need to be addressed with other decisions.

The fire officer must analyze the available information to determine the various alternatives that are available. He or she must be able to identify the advantages and disadvantages of each and how these alternatives may affect other operations on-scene. It is also necessary to evaluate whether or not it is possible to implement each specific course of action given the current conditions and resources. For example, although an interior might be the preferred course of action on a particular structure fire, it may have to be delayed until the building has been ventilated. Once ventilation has been accomplished and crews can enter the building, it also becomes possible to begin salvage operations. This interrelationship between the various alternatives, the decisions rendered, and the results they create are often referred to as "branching."

The fire officer must also recognize that no alternative is without risks. The best alternative is one that offers the greatest potential outcome for the degree of risk involved. This is essentially a "cost-benefit analysis." As long as the benefits outweigh the costs or risks, the solution may be a viable one. An alternative that involves risk of death or injury is not acceptable, except perhaps to save a life.

Determining Objectives

An objective is a statement of measurable performance that identifies the task(s) to be completed. In the fire service, these objectives can be fit into three categories based on when they are established.

Predetermined objectives are those that are established during activities such as prefire planning, company inspections, and fire department training or drills. Based on potential scenarios, these are the objectives the fire officer anticipates accomplishing. They may or may not be necessary, depending on the actual incident.

Operational objectives are those that are developed at the actual time of the emergency. They may use predetermined objectives as a foundation, but are based specifically on observations made during the size-up process and the divisions of fire fighting (RECEO).

Post-determined objectives are established after the emergency is over, usually during a critique or post incident analysis. This is where the fire officer has a chance to evaluate decisions made during the emergency, and the results of those decisions. Post-determined objectives give the fire officer a foundation for improving performance the next time he or she is in a similar situation.

Obviously, most decisions will be made at the emergency scene. But, those decisions are a lot easier to make in the heat of battle when based on predetermined and post-determined objectives developed through prefire planning, drills, and critiques, and when based on established systems such as RECEO.

It is also important that the fire officer establish objectives that are achievable with the resources available. The objectives must be designed with measurable results such that anyone, not just the person who established them, can identify whether or not the objectives have been met. The objectives must adhere to department SOPs. They must also be coordinated with the objectives of other officers or agencies on-scene. Finally, when there are multiple objectives and it is not possible to accomplish all of them at once, it will be necessary to prioritize.

Prioritizing Objectives

The process of prioritizing is somewhat subjective. Not everyone will prioritize objectives in exactly the same way. Each fire officer will have a different knowledge base and different experiences. Each may perceive an incident differently. However, at any emergency scene, priorities will center around protecting lives, controlling the incident, protecting the environment, and protecting property.

The first priority will be always be to handle anything that directly or indirectly endangers the lives of fire fighters or civilians. And, while the fire service exists to protect the public who may not be able to protect themselves, it must be remembered that personal safety comes first. A fire fighter who is killed or injured will not be able to help anyone else.

Anything that might cause the incident to escalate must be managed next. This would include such things as vertical fire spread, tank ruptures, structural collapse, explosions, leaks, etc. Any conditions that might seriously hamper fire department operations should be included as well. For example, a structure fully charged with smoke and heated gases will be untenable for fire fighters. It would have to be ventilated in order to make an aggressive interior attack.

Protecting the environment has become a significant concern in recent years, particularly with hazardous materials incidents. Even when it comes to fires, the Incident Commander must at least be thinking about the possible impact of drifting smoke and products of combustion, and runoff from the water used for fire fighting. What kind of impact will this have on the environment? What can be done to minimize the negative effects?

Finally, the fire officer must determine what can be done to protect property. This includes the structure, contents of the fire building and surrounding exposures.

Evaluating Results

It is necessary to monitor operations and evaluate results throughout the incident. How are the decisions impacting other activities? Is the objective still desirable? Have the priorities changed? Are the resources assigned sufficient to accomplish the objectives? Are the objectives producing the desired results? What other decisions are needed at this stage of the incident?

An emergency scene is a dynamic environment where things are constantly changing. The fire officer must continue to assess the problem and evaluate the results of his or her decisions. Not every decision that a fire officer makes will be the right one. The fire officer must be able to recognize when one decision is not working, or when it is contributing to the problem, and be able to adjust accordingly.

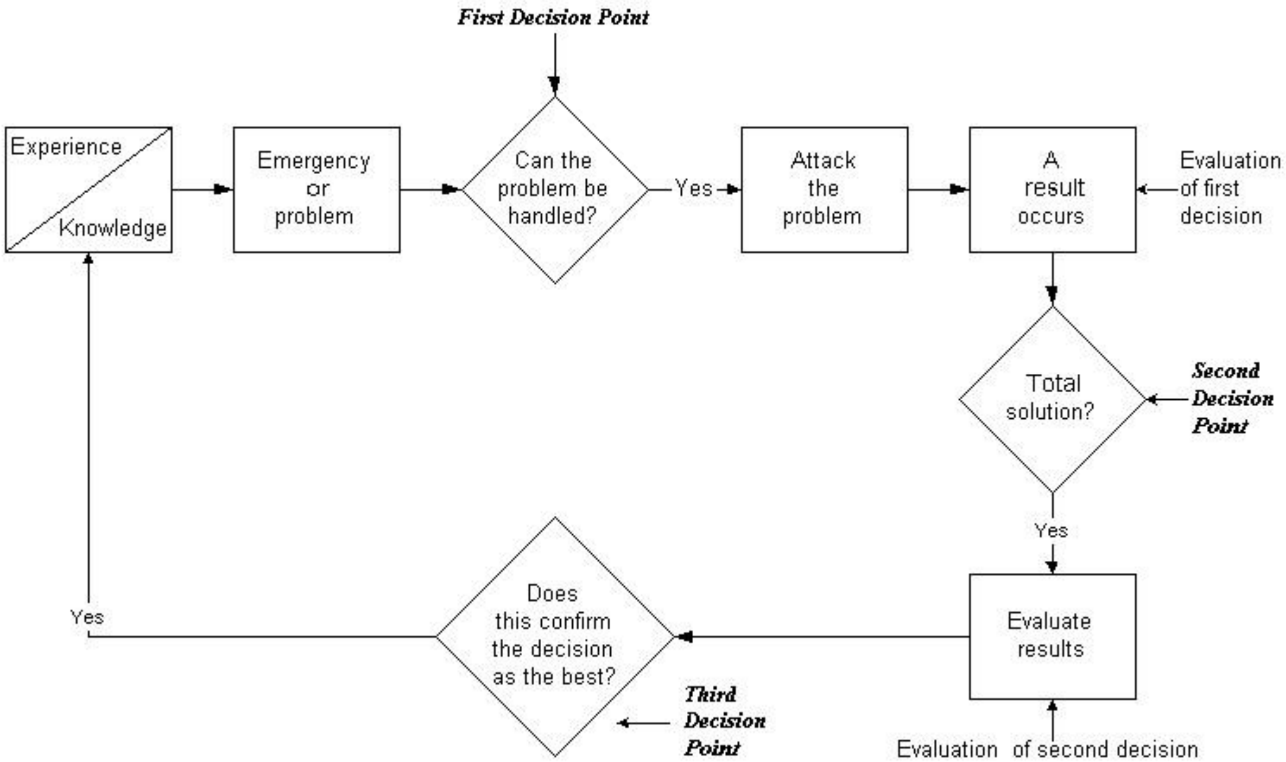
Decision Models

The decision making process can be expressed in the form of models. Figure 32.1 shows a simple decision model for problems that can be handled by the first-in company. This decision model does not identify specific fireground objectives. Rather, it illustrates a process that applies to making any decision.

In this case, the fire officer is faced with an emergency or problem. He or she must first determine whether it can be handled with the resources immediately available on-scene. A trash fire, a vehicle fire, or small grass fires are examples of problems that usually can be handled. The officer analyzes the possible solutions and decides on a specific plan of action. The results are then evaluated to determine if the appropriate actions were taken.

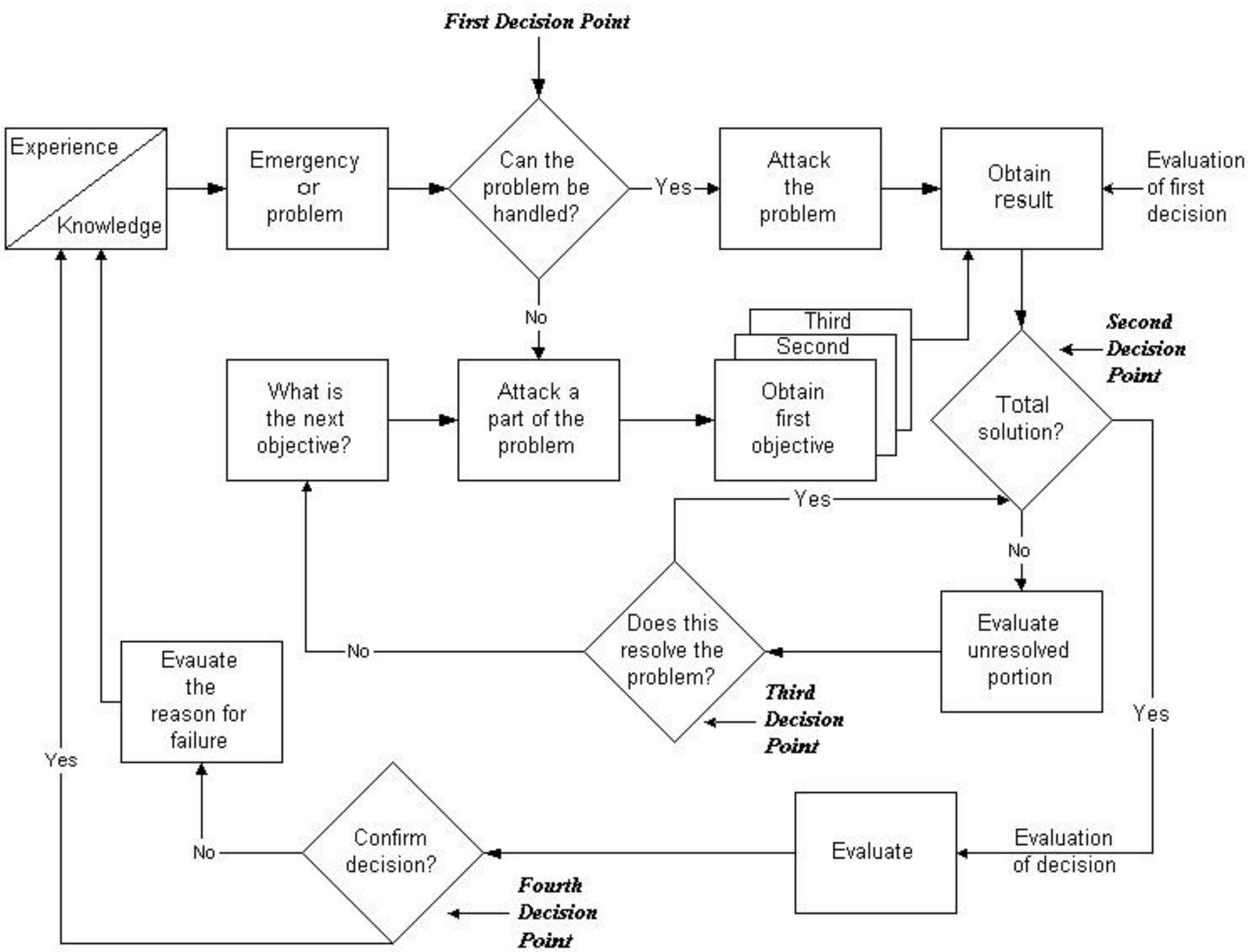
The entire decision-making process ties back to an officer's base of knowledge and experience. He or she uses that knowledge and experience to make decisions. If the decisions were right, the officer will be confident about making those same decisions if faced with the same problem again. If the decisions were not right, the officer must determine what should have been done differently to produce the desired result. It is part of the learning process.

Figure 32.1: A Simple Decision Model



When the problem cannot be handled by the units immediately available on-scene, it becomes necessary to attack parts of the problem individually. Figure 32.2 shows a complex decision model that illustrates how parts of the problem are addressed with individual objectives. Once each objective is complete, the results are evaluated to determine whether the problem has been completely resolved. If not, additional objectives are identified and implemented until the desired results are obtained.

Figure 32.2: A Complex Decision Model



Profiling the Decision Maker

NEEDS OF DECISION MAKERS	
Constant Feedback (Progress Reports)	The use of progress reports gives dimension to decisions. This should not be a constant stream of chatter, but rather a statement of the results achieved. Feedback should be based on established objectives and any obstacles encountered.
Continuous Evaluation	Continuous evaluation of the problem prevents tunnel vision. The officer in charge has to be in a position physically and mentally to re-evaluate what is happening as a result of his or her decisions.
ABILITIES OF DECISION MAKERS	
Ability to Increase "Channels"	The fire officer must be able to receive input from a variety of sources. The developing organization under the Incident Command System puts other officers in the position of being additional eyes and ears for the Incident Commander.
Ability to Prioritize	If it is not possible to do everything at once, the fire officer will have to prioritize the various objectives. As each one is accomplished, or as more resources become available, the fire officer will need to establish new priorities.
Ability to Delegate	The fire officer must be able to delegate objectives to other officers in order to keep the demands manageable. He or she must be able to group these objectives or responsibilities in a logical manner, keeping related objectives together.
Ability to "Filter" Data and Requests	Not all information or requests are important. The fire officer must be able to filter out information that is not significant and tactfully deny requests that are not in alignment with the overall objectives.
Ability to "Write Off" Losses	Decisions to get ahead of the fire often mean writing off losses. The fire officer must be able to recognize those objectives that will do the most good and be able to "let go" of those things that he or she cannot control.
FACTORS INFLUENCING DECISION MAKERS	
Supplemental Information	Perception of objectives and priorities may change as more information becomes available.
Staff and Subordinate Input	Feedback and progress reports must be weighed and considered.
Effects of Control Efforts	What are the results of your operations?
Escalation of the Problem	If the problem escalates, it will be necessary to re-evaluate objectives and priorities.
Stress	Both mental and physical effects.

Post Incident Analysis

Each emergency should be reviewed or critiqued as part of an overall program to improve individual, company and department operations.

In order to ensure a successful critique, it is necessary to maintain a constructive, objective atmosphere. The focus should be on evaluating the fireground activities to determine if they produced the desired results. It is not appropriate to place blame. The key is to focus on the task or procedure rather than the individual who took the action.

An agenda should be prepared ahead of time and a moderator should be assigned to keep the critique on track and to ensure that all-important points are covered. Everyone should have an equal opportunity to participate in the critique.

The following is a sample procedure for conducting a post incident analysis, followed by a list of suggested topics that can be used as an outline.

Sample Procedure for Conducting a Post Incident Analysis (PIA)

The goal of a post incident analysis (or post fire analysis) is to improve the effectiveness of emergency scene operations.

I. Objectives

   A. To improve emergency scene operations.

   B. To identify and correct potential problems.

   C. To give all responding personnel an opportunity to participate in a constructive analysis of the incident examining roles, procedures and incident factors.

   D. To allow all members of the fire department to learn and benefit from the experience of those who participated in major or unusual fires or incidents.

II. Types of Fires to Be Analyzed

   A. Large dollar loss (50,000+).

   B. Loss of life to citizens or fire fighters.

   C. Injury or "close call" to fire fighters.

   D. Suspicious incidents.

   E. Unusual or extraordinary incidents.

   F. Any other incident deemed appropriate by management.

III. System of Analysis

   A. Scene debriefing (Single company or multiple companies)

      1. Before leaving the emergency scene, each company shall review and analyze its operations.

2. Company officers shall review any concerns that need attention either before leaving the scene or before a more formal critique.
3. Any company member may be requested to prepare an incident report, giving details of the incident.

B. Incident Critique or Post Incident Analysis (PIA)

1. As soon as possible after the incident, and no later than the next on-duty tour, every officer involved in the incident (and any other member as requested) shall review and analyze his/her respective operations using the Incident Critique Outline as a guide.
2. Battalion Chiefs shall review the reports and, if applicable, forward them for information and training purposes. Battalion Chiefs should copy reports for distribution if a platoon-level Post Incident Analysis is to be conducted.
3. The Post Incident Analysis shall include the officer in charge of the incident, all responding platoon personnel, other involved officers (if applicable), the Operations Chief, a member of the Training Division and the fire investigator.

C. The Battalion Chief will notify all participants of the time and location of the Post Incident Analysis

1. The officer in charge will lead the discussion using the Incident Critique Outline as a guide. He/she will summarize actions, conclusions, and recommendations.
2. Other involved officers shall report on their respective operations utilizing previously prepared reports and information discussed on-scene following the incident. They shall include all conclusions and recommendations. These reports should be made in order of arrival at the emergency scene. In the event that off duty personnel are not available, the officer in charge will present individual reports.
3. The fire investigator will provide information regarding fire losses, causes, and/or other pertinent data.
4. If conclusions and recommendations include proposed changes in roles, procedures, equipment; or merit documentation of significant incident factors; a brief written report shall be prepared. A designated company member will prepare the report and forward it to the responsible Battalion Chief for follow-up.

D. Training

1. If deemed appropriate, a special training session on any incident can be prepared and presented by the Training Division.

Incident Critique Outline

(Suggested Topics for the Post Incident Analysis)

The following topics are listed as a guide for discussion of emergency scene operations. Discussion should cover *who, what, when, where, why* and *how* tasks were assigned and completed.

#	TOPIC	QUESTIONS
1	Alarm	• How was the alarm received? • Was the dispatch information correct? • Were the communications satisfactory? • What was the time of alarm? • Can this procedure be improved?
2	Response	• Was the initial response adequate? • Did the closest company respond? • Were the proper routes taken considering the time of day, traffic, and construction problems?
3	Size-Up	• Was an appropriate report of conditions given by the first-in unit? • Did this help additional responding units? • Discuss the facts, probabilities, and possibilities.
4	Tactics and Strategy	• What was the fire strategy? • Why was this strategy employed? • Was this the most effective strategy? • What were the initial tactical objectives? • What was the plan of attack? • Was this an offensive or defensive operation? • What outside help was needed (ambulance, police, other)?
5	Initial Orders	• What were the first orders given? • Did any problems arise with the initial operations (e.g. too long lay, not enough water)? • How were orders communicated? • How were apparatus placed at the incident? • Were orders understood? Were communications satisfactory?
6	Rescue	• Was there a rescue problem? If so, what was it? • Could the initial response assignment handle the rescue problem? • What operations were needed to facilitate rescue?
7	Exposures	• What exposure problems existed (interior and exterior)? • What measures could have been taken to limit fire extension?

#	TOPIC	QUESTIONS
8	Confinement	• How did the fire extend from the area of origin (horizontally, vertically, other)? • Was the fire confined with initial line placement? • Was the fire confined to the smallest area in the shortest time? • Could other means of confinement been employed?
9	Extinguishment	• What extinguishing agent was employed? • Was the application effective? • Would another extinguishing agent have been more effective? • Was water applied using adequate volume and pressure? • Was the best type of application utilized (fog or straight stream, hand lines or master stream appliances)? • How was the attack (direct or indirect) related to the phase of the fire?
10	Ventilation	• How was ventilation coordinated with the attack? • What was the ventilation technique used? • Did ventilation produce positive results? • Did ventilation cause additional problems?
11	Salvage	• What salvage actions were taken before, during, and after the attack? • Did salvage procedures reduce the fire or water damage? • Were security operations undertaken? • How could salvage procedures have been improved?
12	Overhaul	• Were contents left undisturbed prior to overhaul to allow for investigation? • Were the objectives of overhaul obtained? • Was the structure released to an authorized person?
13	Water Supply	• Were apparatus able to supply the hose lays ordered? • Was the water system capable of supplying the needed fire flow? • Were the pumpers placed in such a manner to fully utilize the available water? • Was hydrant spacing satisfactory?
14	Investigation	• Were there any indications of arson (multiple fires, unusual smoke or odor, damaged fire protection systems or equipment, etc.)? • Was there a major area of involvement upon arrival? • How soon was the fire investigator notified? • Did responding personnel communicate their observations to the fire investigator? • Was evidence retained for the fire investigator? • What was the area of origin? • What was the cause?

#	TOPIC	QUESTIONS
15	Prefire Plan	• Was there a prefire plan? • If so, was it used? If not, why not? • When was the last prefire plan written? • Does the prefire plan need to be changed or updated?
16	Communications	• Was a communications plan established? • What means of communications were used (radios, face-to-face)? • Was this means of communications the most effective? • What communications problems arose during the incident?
17	Public Information	• Was a Public Information Officer assigned? • Was the media dealt with tactfully and courteously? • Was the media provided with all the information they needed? • Were there any problems with the media? • Was the media helpful in communicating important information to the public? • What information was broadcast/printed on this incident?
18	Safety (fire fighter/public)	• Was a Safety Officer assigned to the incident? • Were all operations conducted in a safe manner? • Did all personnel use the appropriate safety equipment? • Was other safety equipment needed? • Is it necessary to reevaluate or change any procedures to ensure safety on the fireground? • Was the safety of the public considered?
19	Unexpected Contingencies	• What unexpected problems came up? • How were these unexpected problems handled? • What other problems might have arisen? • How would they have been handled?
20	Utilities	• Who shut off the utilities? • When were they shut off? • Was time lost in searching for shut-off switches and valves? • Was the utility company called? • How long did it take them to respond?
21	Command	• Was a command post established? • Where was the command post located? • Were all officers aware of the location of the command post? • How was the command post identified? • Were resources (personnel and equipment) used to the best advantage? • Was ICS used to manage resources? • Were there any problems using the Incident Command System?

#	TOPIC	QUESTIONS
22	Public Relations	• Did anything occur which might adversely affect public relations? • What good feedback was received regarding public relations?

Summary

The ability to make decisions under pressure is essential for any fire officer. This involves analyzing the problem, evaluating alternatives and their possible impacts, determining objectives, and prioritizing those objectives. The fire officer must continually evaluate the results of decisions made throughout the operation and adjust as needed. Two decision models were presented in this chapter to help illustrate how these various components in the decision making process are interrelated.

Some of the decisions made on the fireground are based on experience and lessons learned at previous incidents. The process of conducting a post incident analysis is an evaluation of fireground activities to determine if they produced the desired results. The focus is not to place blame, but rather to take a careful look at what works and what does not work. The ultimate goal is to improve individual, company and department operations.

Chapter Review Questions

1. Why is it so critical in the fire service to thoroughly identify problems before making decisions?

   ____
   ____
   ____
   ____

2. What is meant by the term "branching?"

   ____
   ____
   ____

3. List the three categories of objectives and give a brief description of each.

   ____
   ____
   ____

4. What guidelines should be followed when determining objectives?

5. What are some guidelines for determining objectives?

6. What are some questions that the fire officer must look at in evaluating results?

7. Provide a brief profile of a decision maker.

   Needs of the decision maker:

   Abilities of the decision maker:

   Factors influencing the decision maker:

8. List some guidelines for ensuring a successful post incident analysis.

9. What six factors should be addressed during the post incident analysis when evaluating tasks assigned and completed?

10. List some of the key topics that should be addressed during the post incident analysis.

Topic 33: Communications

Communications in a vital aspect of any emergency scene. It is the link by which all elements of the organization are tied together on the fireground. Efficiency of fireground communications can often be measured by the quality and amount of communications. Effective command cannot occur in the absence of effective communication.

Communication Methods

There are two methods of verbally communicating on the fireground: radio and face-to-face. Table 33.1 outlines the advantages and disadvantages of each.

Table 33.1: Methods of Communicating on the Fireground

Method	Advantages	Disadvantages
Radio	• Rapid. • Does not require personnel to gather at a single point. • Ability to broadcast information to the entire incident scene (emergency evacuation notice, hazards, etc.)	• Awkward to give lengthy, complex instructions. • Not every fire fighter has a radio. • Unable to gauge reactions. • Competition for "air time." • Dead spaces within buildings and radio problems will prevent the message from being heard by all. • Radio traffic may be heard by the public and the media with scanners. • Radio traffic may be recorded at the dispatch center. • Impersonal.
Face-to-face	• Direct, with opportunity for questions and discussion. • Reduces demand for "air time."	• Logistically awkward at large incidents. • Time consuming.

Selecting a method of communication depends on many variables. However, radios are generally more efficient and best suited for the vast majority of fireground communications. Face-to-face communication should be used when there is a change of command. It is also best when messages or information are lengthy, complex, require discussion, or require personnel to visually see something such as a map, prefire plan or other items which cannot be adequately described over the air. Face-to-face communication should also be used when it is preferred that the discussion is not overheard by the public and the media, or when communications may be recorded at the dispatch center, and what is said could be a problem in court someday.

Communication Styles

There are three distinct styles of communication that may be used by the fire officer: permissive, autocratic, and consultative.

Permissive Style

The permissive style is basically a "do what you think best" approach where the fire officer identifies the objective(s) for his or her crew, then allows them the maximum freedom to determine how they will carry out the mission. It provides no guidelines or restrictions. It is usually employed in situations when subordinates are extremely competent and predictable, the Incident Commander is overwhelmed and must delegate responsibility to others, or when the Incident Commander relinquishes command to another officer.

Autocratic Style

The autocratic style is very much the opposite; the fire officer provides very specific directions and instructions. The fire officer does not delegate authority, but instead retains that authority himself or herself. The autocratic style is most appropriate in dangerous situations where fire fighters may lack sufficient training, skills or experience to ensure their safety. It may also be used when the Incident Commander desires a greater level of control over tactics, strategy, and methods employed on the fireground.

Consultative Style

The consultative style is the most desirable method of the three. In this case, the fire officer discusses the problems, objectives and possible solutions with his or her crew, and solicits their input before arriving at a final decision. It provides for a sharing of responsibilities between officers and their subordinates. It enhances the fire fighters' sense of participation. It also gives the fire officer the benefit of additional insight and expertise. The consultative style is used most frequently when a high level of teamwork exists between personnel, and when the fire officer feels comfortable in delegating authority to subordinates.

Radio Communications

It is important when using radios for communication to be both professional and courteous. Be brief, specific, and clear in your communications. Know what you are going to say before you "key" the microphone. Use a common language and standard fire fighting terms that can be understood by all; use "clear text." Operational orders should be specific. Messages on the fireground should be task specific.

Use a natural tone of voice when speaking into the radio. Avoid whispering, shouting or speaking at a rapid rate. Avoid distracting mechanisms that might impact the clarity of your message.

Remember that there may be a lot of competition for airtime, particularly at a large incident. Critical messages must be given the highest priority. It is important to maintain radio discipline.

Make sure that the receiver is ready for your message. Do not interrupt others unless it is an emergency. When you give an order, make sure that it is clearly understood. Acknowledgment is best done by repeating the order when it is received.

Command Considerations

Recognize that radios are a resource, just like any other piece of equipment on the fireground. When radios are limited, it may be necessary to collect available radios and redistribute them. Command personnel will have the first priority.

If multiple channels are available, it may appropriate to work the emergency on more than one frequency. For example, one frequency could be assigned for "command," and a second to "operations." It is not necessary for everyone on the fireground to hear all the radio traffic.

If there are problems with radio communications (too much radio traffic, "dead areas" where the radios don't pick up, too much static, etc.), it may be appropriate to utilize runners for both verbal and written communications.

Conflicting Orders

It is common to receive conflicting orders at the scene of an emergency. It often happens where fire fighters are en route from one task to another or when they are headed to the apparatus to get a tool. Conflicting orders can be minimized by adhering to the chain of command.

Usually the best way to manage the situation when a conflicting order is received is to advise the second officer of the original assignment. He or she may either pre-empt the original assignment or find someone else to carry out the second order. It may even be necessary to advise both parties of the conflict and let them establish priorities together. The most important thing is to make sure that the first officer is advised if there is going to be a delay in carrying out that original order.

Emergency Evacuation Order

It may be necessary on occasion to evacuate all fire personnel from an interior operation because of an impending structural collapse or other hazardous condition inside, or simply to conduct a role call to locate lost personnel. There must be a predetermined signal in place, and all personnel must be aware of that system, including crews from other agencies. Usually this evacuation order involves a verbal signal given over the radio followed by a series of blasts on the air horn.

Sample Fireground Building Evacuation Signal Procedures

It shall be the responsibility of the Incident Commander, or his/her designee, to initiate emergency evacuation signal procedures if at any time the building is considered to be unsafe. It shall be the responsibility of all personnel to be familiar with this procedure.

Immediate Building Evacuation

Periodically during fire operations, extraordinary circumstances will precipitate the need to ***immediately evacuate*** the building. This would be done in the event of an impending building collapse or the discovery of some extraordinary hazard to fire personnel. At that point the Incident Commander, or his/her designee, will make the following announcement over the tactical operations frequency being used: ***"This is an emergency building evacuation!"*** The transmission shall be repeated three (3) times to ensure that all units and personnel have heard the alert. All personnel who hear this alert will immediately evacuate the fire building.

Upon completion of the final radio transmission, the IC or his/her designee will communicate the signal to activate the apparatus air horns. Every engineer who is near any apparatus shall, upon hearing the order from the Incident Commander, depress the air horn button continuously for a period of thirty (30) seconds. This is to ensure that personnel operating inside the building who do not have radios will be warned of the hazard.

Fire fighters who are operating in or near the building shall ***evacuate immediately!*** The only equipment removed from the building should be that which is necessary to facilitate escape. Hoselines should be abandoned unless necessary for protection. ***Remember: the hazard is immediate!*** Every second counts! Once they are outside and safe, personnel should report to their company officer.

Summary

Communications is a vital aspect of any emergency operation. Communications on the fireground may be by radio or face-to-face. There are advantages and disadvantages to each. The fire officer must determine which will best meet his or her needs at the time. Fire officers must also be familiar with guidelines for using the radios; both in terms of ensuring clear communications and to best manage the radio traffic at an incident.

There are three distinct styles of communication that may be used by the fire officer: permissive, autocratic, and consultative. The consultative style is the most desirable of the three since it gives the fire officer the benefit of additional insight and experience, plus enhances the fire fighters' scene of participation. However, the style used will depend on the urgency of the situation and the fire fighters' level of training, skills, or expertise.

Chapter Review Questions

1. List some of the advantages and disadvantages of radio communication.

   ____

   ____

2. List some of the advantages and disadvantages of face-to-face communication.

   ____

   ____

   ____

3. List a situation where face-to-face communication is preferred over radio communication.

4. Briefly, describe the three styles of communication that may be used by the fire officer.

5. What are some guidelines for providing professional and courteous radio communications?

6. What is usually the best way to deal with conflicting orders?

7. What is the recommended way to give an emergency evacuation order?

Topic 34: Management by Objectives

There are a number of different management styles and techniques available to the fire officer. We have heard of such styles as "Management by Exception" and "Management by Crisis." However, the technique which is much more suited to the fire service is called "Management by Objectives" or MBO. Since the size-up process is based on setting objectives, it sets the stage for this management style.

The Basis of Management by Objectives

Management by Objectives (MBO) is a method of controlling efforts by identifying tasks and results to be obtained, and allotting resources towards that end. An "objective" is a statement of measurable performance that identifies what task is to be accomplished, who is to execute it, when it is to be completed, and how well it is to be done upon completion. Notice that it does not include a description of how the task is to be completed.

MBO has seen tremendous popularity in the business community. Yet, it applies equally well on the fireground. In fact, many fire officers have used the principles of MBO for years, even if they had received no formal training in it. It is not a new concept. Nor, is it an answer for all problems. However, it does help to formalize good management practices.

Once again, MBO is results oriented. It requires the fire officer to look at the questions: "What do we want to accomplish?" and "What does it take to get there?" It identifies the overall tasks to be completed, but not how they are accomplished. That decision is left to the individual company officers and their crews.

In employing MBO on the fireground, the first-in officer conducts the normal size-up process. Decisions are then made regarding the objectives to be accomplished. Finally, resources are requested and committed to the specific objectives identified, whether they are strategic or tactical. If command is transferred to a senior officer, that first-in officer must be sure to communicate those objectives and allocation of resources so that the process is not interrupted.

Benefits of MBO

MBO works well with the traditional fire department organizational structure and is easily integrated into the size-up process. It also compels the Incident Commander to establish objectives before assigning resources. This becomes very critical in situations such as a hazardous materials incident where a Site Safety Plan with specific objectives is required by law before entry is made.

MBO allows for more input from lower levels to the Incident Commander. It encourages the use of the consultative style of communication. The Incident Commander is not required to give exhaustive details concerning methods. He or she provides the overall strategy. The company officer establishes the tactics, and the crew determines the methods. This also prevents wasting resources on less important tasks.

MBO Considerations

In order for MBO to be successful, all personnel must understand how it works and what their roles will be. It is not necessary for them to receive formal training as managers in the business community might receive. However, they must understand how objectives are determined, how they are communicated to the individuals who will accomplish them, how the results are measured, and how to identify and correct problems along the way. MBO is a process, not a step or a phase. It is applied whenever applicable. And, it requires the participation of individuals who are capable of functioning and making decisions without close supervision.

Summary

Management by Objectives (MBO) is a management style that is results oriented. It requires the fire officer to consider the questions: "What do we want to accomplish?" and "What does it take to get there?" He or she must then allocate the necessary resources to accomplish those tasks. The individual company officers and their crews are the ones who actually determine how the task gets done.

Chapter Review Questions

1. What is meant by "Management by Objectives"?

2. What is an objective? What should it include?

3. What decisions are left for the individual company officers and their crews?

4. What are some of the benefits of using MBO?

Activity 34-1

TITLE:	Management by Objectives
INTRODUCTION:	This activity is designed to help illustrate how the fire officer should use MBO on the fireground.
DIRECTIONS:	1. The first line is filled in as an example. 2. Identify several objectives or tasks that may need to be accomplished on the fireground (or other emergency scene). 3. For each objective, identify who will be assigned that task, when it is to be completed, and how well is to be done (or how successful completion will be measured). 4. In the far right column, list some of the methods that should be determined by the company officer and his or her crew. 5. Be prepared to discuss your answers with the class.

Objective	Assigned to	Time for Completion	Measurement(s)	Methods
Ventilate the roof.	Truck 1	Immediately - prior to entry by "fire attack."	Cut a 4' x 4' hole directly above the fire to relieve pressure and prevent a backdraft.	Which specific tool to use for cutting the hole? Which hoseline to take up for protection? Who will handle each part of the assignment? Where to place ladders for access?

Objective	Assigned to	Time for Completion	Measurement(s)	Methods

Topic 35: Divisions of Fire Fighting

All emergencies require the performance of numerous activities or operations. The size and complexity of these operations will be based on the size and complexity of the emergency. This chapter provides an overview of major goals of fireground operations, keys to successful scene management, and the divisions of fire fighting.

Major Goals of Fireground Operations

There are four major goals at any fire incident. They are as follows:

1. Provide for fire fighter safety and survival.
2. Protect, remove and provide care for endangered occupants.
3. Stop the fire.
4. Conserve property during and after fire control operations.

Keys to Successful Scene Management

Successful scene management can be divided into three distinct phases: think, plan, and act.

Think

All decisions must be "open-ended" to allow for expansion and reversal. It is important to distinguish between facts and assumptions. Factual information is often incomplete. Assumed information is often all that is available at the time. Be flexible. Require feedback and revise operations when necessary.

Plan

Base plans on information obtained during the "think" step. What has to be done first? These are your overall goals. How is it going to be done? These are the individual objectives.

Act

This is the assignment of tactics to meet objectives. On large incidents, the Incident Commander will not be as involved with tactics as with smaller incidents.

Tactical Priorities: RECEO

Lloyd Layman, in his book entitled "Firefighting Tactics" uses the acronym RECEO to help fire officers remember the essential fireground divisions or priorities. Those divisions include rescue, exposure, confinement, extinguishment, and overhaul. They are listed in their order of importance, and are generally performed in this order. Two additional divisions, ventilation and salvage, are incorporated into the fireground operations where appropriate.

It is important to recognize that these tactical priorities often overlap. And, although they are listed in order of their *general importance*, they may need to be accomplished in a different order depending on the situation and the resources available.

Rescue

Life safety is the first priority at any emergency scene. Although this tactical priority is often referred to as "Rescue," it is not limited to that. Before fire fighters even consider rescue, they must first think of their own personal safety. Is there a reasonable chance of affecting a successful rescue without endangering the fire fighters? There is no sense risking the lives of fire fighters for a body recovery operation.

"Rescue" operations will vary depending on the size of the fire, the type of structure involved, the number and condition of persons to be "rescued," and the resources available. A fire at night in a single-family dwelling will usually require standard search and rescue operations. On the other hand, for a fire in a multi-story hospital, it may be possible to "rescue" more people with an aggressive attack on the fire than by immediately starting a full-scale evacuation. If it becomes necessary to move patients, they should first be relocated either beyond fire doors or to other floors within the hospital. Evacuation is a last resort measure to be used only when it is not possible to protect patients within the hospital.

Exposure Protection

The next priority is exposure protection, the goal being to keep the fire from extending into currently uninvolved areas and compounding the problem. How urgent this tactical priority is will depend in part on proximity of other structures, building construction and type of occupancy. Exposure protection is a defensive action.

Confinement

At this point, efforts should be directed towards confining the fire to the smallest possible area. Both the fire and products of combustion must be kept from spreading either horizontally or vertically. All avenues of fire spread must be secured. It may involve offensive or defensive strategies, or a combination of the two. It may also include the use of built-in fire protection features such as automatic sprinkler or extinguishing systems, fire doors and dampers, and building ventilation systems.

Extinguishment

The ultimate goal at every fire is extinguishment. It usually requires the application of water, but may involve other extinguishing agents. Extinguishment is an offensive operation. However, in a defensive attack, fire extinguishment may only be possible after the structure has burned down to a workable size.

Overhaul

Overhaul is that phase of the operation where fire fighters carefully check the fire area to make sure that everything is completely extinguished so that the fire will not rekindle after the fire department has left the scene. Depending on the condition of the structure and the fuel loading (or contents), overhaul may be relatively brief or may require extensive efforts over a protracted period of time. It may even require the use of special equipment, such as bulldozers, not normally available within the fire department.

Overhaul includes making the structure as safe as possible. For small fires, it may simply require restoring utilities so that the building may be occupied again. For larger fires it may require removing an unsafe roof or arranging for a contractor to board up broken doors and windows, or put a fence up around the structure.

Last, but not least, overhaul includes an investigation to determine the cause of the fire. It is important that fire fighters are careful in both the extinguishment and the overhaul stages not to disturb anything that might be evidence. It is sometimes necessary to delay overhaul efforts until the investigator has finished examining the area, taking pictures and collecting evidence.

Ventilation

Ventilation includes those operations aimed at removing heat, smoke, and fire gases from the structure. It is important to realize that although ventilation appears as an individual objective fairly low on the priority list, it is actually a vital component of almost all the other tactical priorities. It may be necessary to ventilate the structure in order to perform rescue operations; by removing heat, smoke and fire gases it increases the victim's chances of survival and makes it easier for fire fighters to advance into the building. Ventilation provides a safer working environment for fire fighters involved in suppression activities, and facilitates extinguishment by removing some of the heat. Ventilation will reduce overall damage to the structure and contents because there is less heat and smoke, and because less water is needed for extinguishment.

The fire officer may have to choose between vertical and horizontal ventilation. The decision must be based first and foremost on safety. If a backdraft is imminent, vertical ventilation should be used. If it is not safe to put someone on the roof, it will be necessary to use horizontal ventilation. Height of the building, roof construction, and access to the roof are other factors that may need to be considered. In some cases, it may be appropriate to use positive-pressure ventilation to force heat, smoke, and fire gases out by introducing large quantities of cool fresh air.

Salvage

Salvage should also be done as soon as possible to minimize damage from the fire, smoke, and water or other extinguishing agents used. It generally involves covering unburned contents and removing excess water.

The fire officer must be familiar with different methods for protecting valuable contents. Many times the contents are gathered in the center of the room and covered with a salvage cover or plastic sheet. Sometimes it is appropriate to put things inside cabinets or closets if they are intact and safe from future damage. And, on other occasions, it may be necessary to take contents outside and place them in a safe area or bring them directly to the building occupant. Valuable records, photos, and other items that cannot be replaced are generally of most importance to building occupants, as well as personal computers and other equipment that they may have for both business and personal use.

REVAS

Several fire departments in Southern California use a different acronym ("REVAS") for remembering essential fireground divisions or priorities. There are two major differences between REVAS and

RECEO. In REVAS, ventilation is given a definitive spot higher on the priority list. REVAS also distinguishes evacuation as a separate step. The following is an outline of the acronym "REVAS" taken from 1987 Emergency Resource Inc., "Fire Attack" series.

Rescue

- Occupancy type and use
- Number of possible occupants
- Time of day/week
- Primary and secondary search
- Specialized rescue
- Evaluate body recovery versus rescue potential

Evacuation

- Exposures
- Downhill/downwind in the event of a hazardous materials incident
- Police department assistance

Ventilation

- Vertical and horizontal
- Positive versus natural
- Location and size of roof cuts
- Wind direction
- Building configurations

Attack

- Personally view as many sides of the building as possible
- Exposure protection
- Primary and secondary search
  - Timely
  - Adequate resources assigned
  - Complete of search relayed to IC
- Apparatus spotted appropriately
  - Don't block other units
  - Have a way out

  - Don't gang up at the front door
- Fire attack
  - Attack from the unburned interior side
  - Back up
  - GPM versus BTUs
  - Correct size and arrangement of lines
  - Protect interior access and escape routes
  - Protect search crews
  - Write off property already lost
  - Confine the fire
  - Check for extension
  - Coordinate with proper ventilation
- Water supply
  - Adequate volume available
  - Adequate personnel and equipment available
  - Large diameter supply lines
  - Relay pumping
  - Drafting
  - Tanker shuttle

Salvage

- Salvage assessment
- Save irreplaceable, high ticket items
- Remove
- Cover
- Ventilate

Summary

There are four major goals at any fire incident: provide for fire fighter safety, protect endangered occupants, stop the fire, and conserve property. These can be accomplished by through a series of fireground divisions or priorities that Lloyd Layman defined with the acronym RECEO. Those divisions include rescue, exposure, confinement, extinguishment, and overhaul. They are listed in their order of importance, and are generally performed in this order. Two additional divisions, ventilation and salvage, are incorporated into the fireground operations where appropriate. These tactical priorities often overlap. And, they may need to be accomplished in a different order depending on the situation and the resources available.

Another system, identified by the acronym REVAS, is used by several departments in Southern California. There are two major differences between REVAS and RECEO. In REVAS, ventilation is given a definitive spot higher on the priority list. REVAS also distinguishes evacuation as a separate step.

Individual departments may have their own systems that differ from these two. However, regardless of the system used, the fire officer must make sure that all essential fireground priorities are accomplished.

Chapter Review Questions

1. What are the four major goals at any fire incident?

2. What are the three distinct phases of successful scene management?

3. What are the seven tactical priorities identified by RECEO?

4. How should these tactical priorities be ordered (prioritized) on the fireground?

5. What are the reasons for conducting overhaul?

6. List some examples where ventilation can facilitate accomplishing other tactical priorities.

7. What are some ways in which salvage might be accomplished?

8. What are the two major differences between RECEO and REVAS?

Topic 36: Command and Control Components

Efficiency on the fireground depends on exercising command and control over resources. It does not "just happen" by itself, not in the otherwise chaotic presence of an emergency situation. The basic components of the command and control functions include:

- Organization
- Chain of Command
- Span of Control
- Unity of Command
- Division of Labor
- Command Structure
- Supervision/Leadership

This chapter will provide an overview of each of these components and how they fit into the Incident Command System used by the fire service.

Organization

The resources on the fireground must be organized into a manageable entity. Gone are the days when firefighters could "freelance" on the fireground. An organizational structure not only provides for more efficient fireground operations, it also better protects the safety of all personnel

This organization must be flexible. The Incident Command System provides a template, a basic organizational structure that has been tried and tested extensively on a variety of incidents of different sizes. The positions within that structure are designed to accomplish specific objectives. But, the structure is flexible enough to grow in size and scope as the incident escalates, and to shrink again as the incident is brought under control. It is flexible enough that departments of any size can adjust the command structure to accommodate their needs.

The vast majority of fires that any officer might have to command are relatively small in size, single structures requiring only a first or second alarm assignment. The fireground organization, therefore, remains relatively small as well. However, all personnel must be trained on how to implement the Incident Command System on a larger scale for larger incidents. They must have an opportunity to practice those skills either in tabletop exercises or actual drills. And, there must be a written plan in place outlining how the various objectives will be met and the resources available to the Incident Commander. The "real" organization process is based on accomplishing objectives, and not on just the organizational structure.

Chain of Command

The chain of command is a hierarchical structure that defines the roles, relationships, and authority of each member within the department. The following illustrations show different types of command structures, each of which is appropriate for different situations.

Most fire departments are organized like a pyramid with fire fighters at the base and the fire chief on top. This is a very simplified look at the organizational structure within a fire department.

Figure 36.1: Simplified Organizational Structure

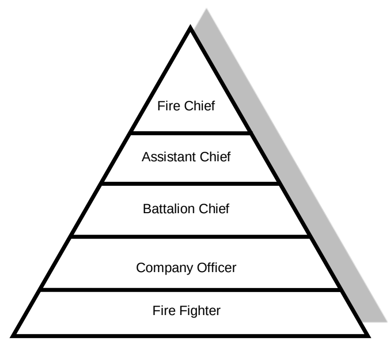


Figure 36.2: Sample Organizational Structure for the Fireground

Figure 36.2 illustrates how the chain of command might look on the fireground with individual engine and truck companies reporting to battalion chiefs or task force leaders. The organizational chart for the department as a whole might include positions for Fire Prevention, Training, Public Education, Fire Investigation, etc., depending on the size of the department.

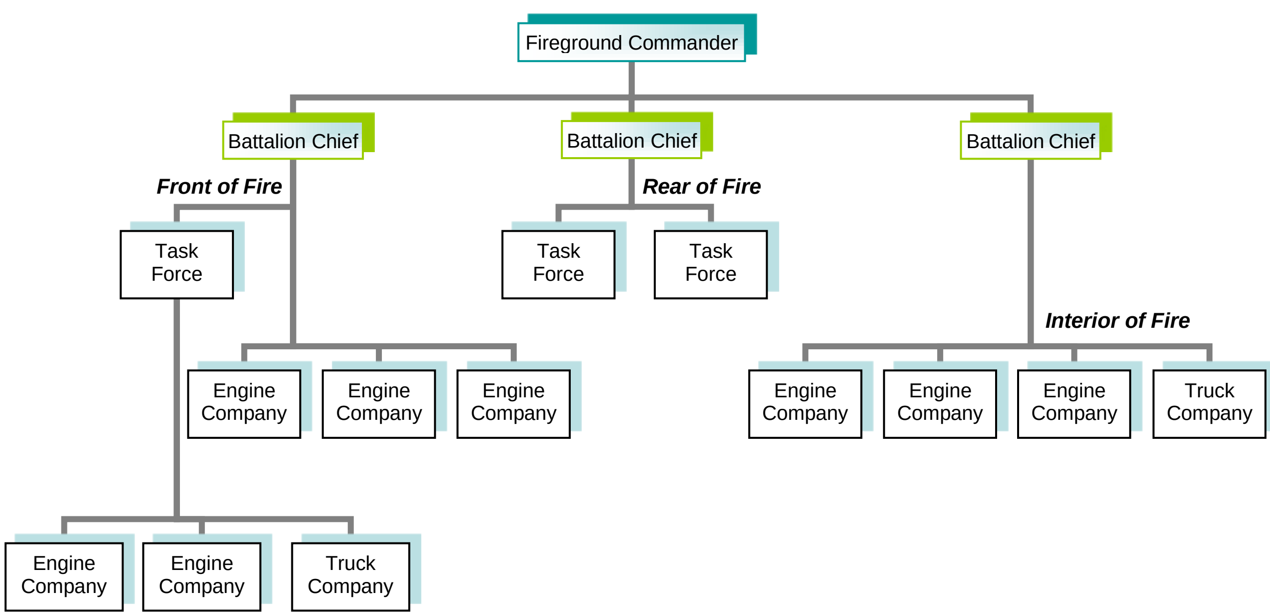
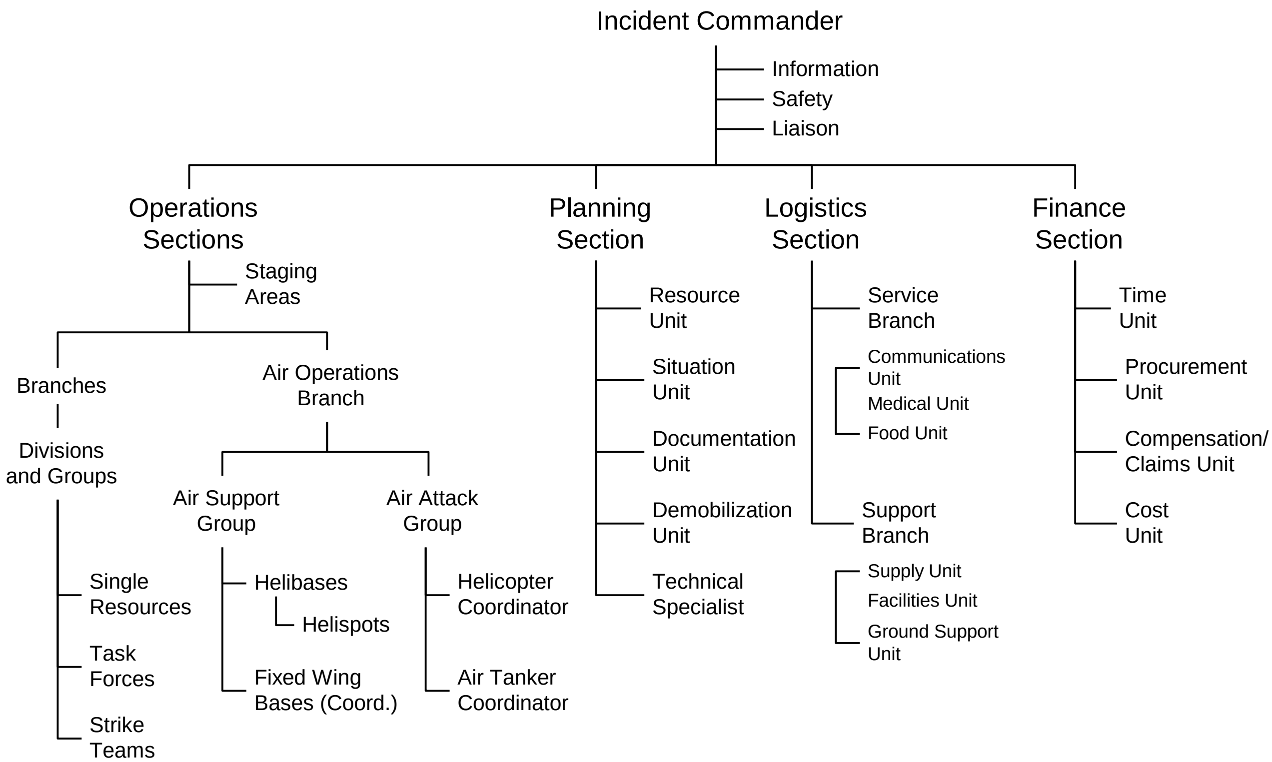


Figure 36.3: Sample ICS Organizational Structure for a Major Wildland Fire



When using the ICS organizational structure the companies or officers are designated by their functions or locations. Figure 36.3 is an example that might be used at a major wildland incident. It will look different for ordinary structure fires, high-rise fires or hazardous materials incidents. The advantage of the Incident Command System is that it provides a management structure that can be modified easily depending on the type and complexity of the incident, and the resources available.

An integral part of the chain of command is ***delegation***, the transfer of authority from one level of the organization to another. While the Incident Commander has overall responsibility for the incident as a whole, he or she will normally depend on other officers to oversee specific tasks or objectives.

The chain of command also facilitates communication. Information and orders are transmitted through the ranks from the Fire Chief or Incident Commander down to the individual fire fighters. The fire fighters, meanwhile, are able to communicate their feedback or information to higher levels in the department through their supervisors. The channels of communication are not only vertical, however. The organizational structure on the fireground also allows for horizontal or lateral communication between individual units.

It is important to note that on the fireground the organization and the chain of command are built from the bottom up. Command officers normally arrive on-scene in the inverse order of their respective positions in the department's rank structure. The first-in company officer has command authority until relieved by a senior officer.

This first-in officer has definite responsibilities with respect to the chain of command. The officer must either assume command upon arrival and exercise his or her command authority without hesitation, or pass command to the next-in officer. The officer must conduct a thorough size-up and provide a report of conditions to keep superior officers and other responding units informed. The first-in fire officer is the foundation for the command structure that follows. He or she must "set the stage" by taking appropriate actions to control the emergency. That will facilitate the transfer of command when a senior officer arrives.

Whether or not command is actually transferred will depend on the extent of the emergency and departmental policies. While it is generally expected that a battalion chief (or other senior officer) will take command of a working structure, it cannot be assumed. Command must be transferred with some kind of formal acknowledgment once both parties are ready. The first-in officer must be prepared to advise the senior officer of conditions on the fireground, what has been done so far, and the objectives that have been already laid out for the crews on-scene. The first-in officer must then be prepared to function in any capacity as needed once command is transferred. In the event that command is not transferred, the fire officer must continue to fulfill the command role, ensuring that all appropriate objectives are being met.

Span of Control

A supervisor can only effectively manage a limited number of subordinates, regardless of his or her rank. Although managerial authorities differ somewhat in their opinions of what that exact number should be, five is the number that is generally accepted in the fire service. The Incident Command System is based on a maximum of five. Once that number is exceeded, a manager's effectiveness begins to drop. It is much more difficult to keep track of what each person or position is doing. Communication between the officer and his or her subordinates begins to suffer. If the emergency situation is intense enough, the responsibilities become overwhelming for that fire officer.

Span of control is frequently exceeded in the initial stages of a major emergency when the situation is most intense and the necessary resources are not yet on-scene. The fire officer must begin creating sections, divisions, or groups as appropriate to ensure proper span of control.

Unity of Command

Just as a fire officer can only effectively manage a limited number of people, each individual can only effectively work for a limited number of managers. The difference, however, is that the number in this case is only one. Each individual must know who he or she reports to and is responsible to. Likewise, officers should avoid giving orders to fire fighters that are not assigned to him or her. There are exceptions to this of course. However, they should be limited to situations where someone's life is endangered.

Unity of command is often violated under the stress of emergency situations, particularly when there is an abundance of fire officers on-scene. Yet, this causes several problems. Fire fighters become confused about what they should be doing on the fireground and who they actually report to. Often the activities on the fireground are less efficient. And, fire officers may find that their expectations are not being met because their fire fighters are being pulled in other directions.

Division of Labor

As more personnel become available on-scene, the work can divided up so that each person or crew may focus on a specific objective. The normal organizational structure of the fire service is divided into line and staff functions. *Line personnel* (fire fighters, company officers and battalion chiefs) have direct responsibility for suppression activities. *Staff personnel* are more management or information oriented, and will fill more of a support role on the fireground. They may be responsible for interfacing with the media, procuring specialized supplies and equipment, or acting as liaison with other agencies.

Under the Incident Command System, work is divided up into sections, divisions, or groups. A "section" is defined by management elements: Operations Section, Planning Section, Logistics Section, etc. A "division" is based on geographical areas. They may be assigned based on the perimeter of the structure (front, rear, north, south, etc.), or by area or floor within a building. A "group" is based on functional responsibilities: Rescue Group, Ventilation Group, Medical Group, etc.

Command Structure

Besides developing an organizational structure with a specific chain of command, the fire officer must establish a command post from which to manage the incident. The command post should be established in a convenient location, a safe distance from the emergency. Once designated, the location of the command post should be announced over the radio, along with the name by which it will be identified. The Incident Commander will then be referred to as "(Incident Name) Command," or "(Incident Name) IC."

Having a stationary command post gives the Incident Commander and his/her staff officers a place to confer and make decisions, as well as a vantage point from which to see. It should be well lit, and hopefully provide some shelter from the rain and wind since the IC may need to review reference materials and preplans, plus begin documentation. Since a battalion chief's car or specially designed command vehicle may be used for the command post, the Incident Commander will have access to a more powerful radio, and possibly a cellular phone. The command post may be very simple, or may be quite elaborate.

Command post locations may be established based on prefire plans of a facility, or more commonly on department SOPs. The first-in officer will usually establish the command post at the front of the building, or at some logical "front" of a fire outdoors. At a highway incident or wildland fire, consideration must be given to the direction of fire spread, wind direction, access, etc. The second command officer is usually placed to the rear of the fire to provide a more complete overview of the fire area. Additional officers will be appointed to sections or divisions by geographical location or task/objective respectively.

Supervision/Leadership

Supervision on the fireground includes establishing objectives, allotting resources and providing data to assist in attaining these objectives, directing tactical operations, monitoring results of the operation (getting feedback), and identifying and correcting small problems before they become large ones. Leadership involves looking out for the welfare and safety of personnel, setting an example, keeping personnel informed of overall progress and strategies, and developing a sense of responsibility in subordinates.

When it becomes necessary to delegate authority, the fire officer should keep the following guidelines in mind. Authority should be delegated within the chain of command to individuals who are capable of the tasks to which they are assigned. They must be given adequate authority to function on their own, but with clearly defined parameters so that they do not run into problems. They must also be provided with adequate resources to complete the task or assignment. The fire officer must also remember that ultimate responsibility cannot be delegated away. He or she must still ensure that all the objectives are being met, even when using others to accomplish those objectives.

Summary

Efficiency on the fireground depends on exercising command and control over resources. There are several components of the command and control functions including organization, chain of command, span of control, unity of command, division of labor, command structure, and supervision/leadership. The fire officer should be familiar with each of these components and how to apply them on the fireground.

Chapter Review Questions

1. What system is recommended as an organizational structure?

2. What are some guidelines for transferring command?

3. What is the recommended number for an effective span of control?

4. What does "Unity of Command" mean?

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5. What are some guidelines for dividing labor?

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6. What are some guidelines for establishing a command post location?

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7. What are some of the things involved in supervision and leadership?

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8. What are some guidelines for delegating authority?

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Appendix A: Simulation Exercises

Overview

At the onset of this course, we identified three broad goals for the curriculum:

1. Identification of those factors that affect fireground operations,
2. Introduction of those managerial techniques necessary to control fireground operations, and
3. Providing the opportunity to employ these techniques in simulated fireground activities.

Hopefully, the first two goals have been attained, and we are now prepared to undertake the third.

Introduction

The following unit is devoted to simulation exercises. This requires a great deal of participation on your part, but will reward your efforts with the opportunity to apply your command skills in a dynamic, challenging atmosphere. Simulation is definitely the most important activity that you will engage in during the course, for it is during these exercises that you can bolster your experience level, as well as your knowledge base.

Your instructor will begin this unit with an overview and orientation to the particular simulator process. Student information sheets included within this unit will augment the orientation session. Do not hesitate to ask any questions that you might have.

Fire fighters who have not experienced simulation exercises will often ask: "What is simulation?" or "Why do we simulate?" The answer to these and other questions regarding simulation are answered in the following material developed by Ronny J. Coleman, former Fire Chief of the Fullerton Fire Department and California State Fire Marshal. Chief Coleman offers information that is essential if you are to receive the full benefit of participating in simulation exercises.

What is Simulation?

Simulation is a method of exercising fire command practices and principles in a classroom environment using mechanical and audiovisual means to produce an emergency incident. It is a technique to provide company officers and command officers an opportunity to size-up an incident and conduct fireground tactics and strategy in a controlled environment. Various fire situations can be created and modified in response to actions that are taken by the various role players.

How Many Different Kinds of Simulation Are There?

How many different kinds of simulation are there? Well, the answer to this question is "Just how many different kinds of fire departments are there?" or "Just how many different kinds of fire problems are there?" or "How many different kinds of training situations do we have in the fire service?"

There are actually dozens of different methods of simulation. However, for the purpose of this program we are going to focus on three different types. These three types are: 1) "Skull session" simulations, 2) Audiovisual or two-dimensional simulations, and 3) gaming tables.

Skull Sessions

What Are Skull Sessions?

A "skull session" is a technique of analyzing fireground situations, both real and hypothetical, using sketches and diagrams, as a means of developing a plan of action for specific "model" problems. It is a technique whereby teams of individuals have an opportunity to review facts, possibilities, and probabilities in a "brainstorming" type environment. Usually skull sessions are a group decision-making effort before working on a dynamic simulator. (Note: "Skull Sessions" is a term coined by the "American Fire Journal.")

How Are Skull Sessions Used?

Skull sessions are distributed to teams of individuals, usually a minimum of three and a maximum of eight. The group is allowed a certain about of time, usually not less than 20 minutes, and not more than 45 minutes. Upon completion of the group's review of the problem, a spokesperson is selected by the team to describe the group's assessment of the problem and the action plan they would have implemented if they would have faced this problem in a real emergency. Each group is asked to discuss its point of view with the rest of the class until all groups have completed the process.

Once all groups are done, the instructor may request the class to develop a consensus regarding either pertinent problems or a specific course of action. The participants in the skull sessions should focus their attention on identifying the major objective to be accomplished using the concepts presented in this course.

How Are Skull Sessions Developed?

Skull sessions are derived from real or hypothetical emergency situations that various departments have experienced. Many of their incidents come from critiques of real emergencies. Others are derived from sketches and diagrams taken from pre-fire plans. In either case, the main issue is the development of a sketch or diagram that outlines the fire problem. You will note that in all cases, pertinent facts such as the size and complexity of the response group are left open for each group to decide. That is done on purpose. It allows for flexibility in dealing with the problem with a variety of resource capabilities. A small fire agency may react differently to a specific fire problem than a task force form a large fire agency. Other details like hydrants and points of street access may likewise be agreed upon by either the instructor or the group to vary a specific problem.

Two-Dimensional Simulations

Two-dimensional simulations are based on an entirely different premise. The two-dimensional simulators generally use two to four different audiovisual means to cast an image on a screen, allowing the participants to visualize the scope and breadth of the problem. These forms of simulators include a means for demonstrating the exterior of a fire problem, a means of locating the fire, and a means of demonstrating smoke spread, smoke locations, etc.

The two-dimensional simulator is used to place an image on the screen. The audiovisual equipment is programmed so that the participant sees clues on the exterior of the building as to what happened on the interior. Being two dimensional, this form of simulation is almost entirely mental. The participant must develop the realism in his or her mind. Because of the fact that this form of realism is difficult to generate easily, the simulator requires an extensive amount of pre-planning and control by the training officer if it is to have the maximum degree of effectiveness. This form of simulation also uses as many other sensory inputs as possible using audiovisual equipment. For example, sound effects may be used to create a sense of realism. Simulated radio and communication systems may be provided to portray the need for communications via an electronic means.

With two-dimensional simulation, there is a high degree of interaction between the controller of the exercise and the participant and the exercise itself. Whatever the participant decides to do will cause the controller to change the visual image on the screen in concert with that decision.

Two-dimensional simulations are not limited in the scope of the problems that they can handle. Depending upon the imaginative use of photography, almost any conceivable kind of an emergency can be visually represented. There are very effective programs done on this type of simulator for watershed fires, structural fires, aircraft crashes, and hazardous materials incidents.

The flexibility is by far the greatest advantage of two-dimensional simulation. It is extremely reasonable in cost to develop relatively sophisticated emergency situations. However, there is a degree of limitation as far as the number of details that can be presented on the screen. For example, this form of simulation is not particularly desirable to simulate a community wide disaster such as an earthquake, flood, or mass casualty incident. That form of training exercise is best handled by using disaster simulation that relies on very different methods.

Another advantage of two-dimensional simulation is the fact that is relatively portable. Many departments have developed simulators that can be transported from station to station or from location to location with a relatively small amount of set up time. This means that two-dimensional simulation can be taken to the audience rather than bringing the audience to the simulation. This is extremely desirable in such things as rural training environments, widely spread out fire departments or in areas where it is desirable to perform most of the training at the company level.

The disadvantage of this form of simulation can sometimes be found in the vulnerability of equipment. For example, this kind of simulation is highly dependent upon projection. Therefore, failure of bulbs, lenses, or the equipment itself at an inopportune time can be devastating to the exercise. Generally speaking, two-dimensional simulation also involves a substantial investment in hardware up front. Depending upon whether the simulator has been purchased outright or has been developed locally, it is not difficult to tie up $3,000 to $4,000.

The bulk of the comments that were developed throughout most of this text, however, were developed for this form of simulation. It is an extremely practical means by which to train officers in the basics of fireground command and control. It is well within the technological capabilities of every fire department. As a training technology, it is closely related to some of the other forms of delivery such as use of slides and movies in a training environment, and is therefore party to the apperceptive base of most training programs.

Gaming Tables

Gaming tables are often used in conjunction with two-way simulators. This is a piece of plywood or two-dimensional map or plot plan that has been laid down to represent the physical layout being shown on the screen with an audiovisual projection. This form of simulation makes use of other devices such as model fire trucks, pieces of twine to represent hose lines, simulated ladders, etc. to demonstrate the proper (or improper) placement of equipment as it is deployed by radio in a simulation exercise. The use of the gaming table with two-dimensional slide projections is beneficial, for it allows the Incident Commander to start developing a mental picture of the deployment of his/her hardware.

Another real distinct advantage of the combination of game tables and two-dimensional audiovisual projection equipment is that many exercises can be run in relatively short time periods. For example, it is conceivable that in a two hour training session with these two forms of simulation, that a properly programmed simulator program could run as many as four exercises. You could fight the same fire four times or fight four different fires in the same period, or you could take the same fire and create four different sets of circumstances to test different approaches.

In any regard, the two-dimensional simulator and the gaming table are extremely flexible training devices, used separately or together.

Why Do We Simulate?

There is a variety of reasons to use simulation. The first reason is to improve command, control, and management skills in combating both routine and unusual emergencies. A simulator can create any number of "experiences" for a command officer that he/she may not face on a day-to-day basis. Simulated fires can create a situation that may not actually occur to an officer for many years into his/her career.

The second reason for simulating is to cause firefighters and officers alike to increase their knowledge of fireground conditions and fire behavior factors as they relate to the spread and growth of fires. In this controlled environment, a fire situation can be modified and predicted in response to actions taken by the role players.

The third is to allow firefighters to experience an emergency in target hazards, before a real incident where loss of life and property may be costly. By using simulation, officers can evaluate their fireground procedures and decision making in relation to these particular hazards.

The fourth and final reason for simulation is to assist in the improvement of communication skills and radio procedures.

The fire command simulator is designed to bridge the gap between theory and actual practice on the fireground in the areas of communications and command. It is not a substitute for actual experience, but rather a more realistic attempt to evoke responses under stress conditions and to shorten the period of training conditions so that the trainee can be exposed to a maximum number of situations in a minimum amount of time.

The exercises are primarily for the purpose of:

- Exposing a trainee to many problems and conditions requiring decisions.
- Exercising the trainee's ability to coordinate the activities of many units.
- Giving the trainee an opportunity to evaluate his/her own decisions after the termination of the problem.
- Evaluating the application and limitations of practices and procedures.
- Providing opportunity to systematically research, under laboratory conditions, experimental suggested changes in practices and procedures.

How Is Simulation Done?

A fire simulator consists of a combination of overhead projectors, 35 mm projectors, a mechanism for reproducing "fire" or "smoke," and an audio system that simulates a radio frequency or frequencies.

A 35 mm slide that is projected on the primary screen provides the basis of the exercise. This slide may be of a single-family dwelling, multiple family dwelling, and industrial or commercial structure. It may also consist of a target hazard such as a lumberyard, water shed situation, vehicle, aircraft or tank farm. Almost any fire situation can be created. At the start of a simulation exercise, only the projected image of the fire location is seen on the screen.

An overhead projector is used to project an additional image over this fire problem. The red for fire and the light gray for smoke is held back by a light trap. Utilizing the problems of fire behavior, an instructor will create a problem by displacing either smoke or fire coming from the building. By removing the light trap, the simulator operator can create a variety of visual impressions. Smoke or fire can be seen coming from buildings, windows, roofs, etc.

A simulator operator can manipulate the fire behavior in response to the actions taken by participants or as directed by instructional staff. The fire can extend vertically or horizontally, create exposure fires, etc.

As decisions are made by the various role players, the operator can also restrict the fire spread or smoke spread to give the appearance of fire control.

A communication system is utilized by the role players to simulate communications between officers, communications with outside agencies and with the dispatch center. A separate amplification system is also utilized to provide background noises or fire, sirens, explosions, etc.

The last component of a simulator is a display board that shows where equipment is placed, lines are laid, ventilation occurs, etc. This is three dimensional on a projected system.

Environment

Participation in this exercise must be as real as possible, but the exercise depends on the trainee's ability to "fill" his/her role. The students will find the classroom environment is not a typical "classroom." It should be devoid of all materials not necessary to the exercise.

Role Playing

Each participant will be assigned a "role" to perform during the exercise. This role may be Incident Commander, Company Officer, Chief Officer, Dispatcher, Facilitator, etc. Each role player is expected to carry out the responsibilities and duties of the assigned position. They will be expected to give appropriate orders, react, and communicate as they would on a real incident. Role players must respond using accepted principles of fireground operations and tactics.

Each role player is provided with a scenario of written or oral facts. They should initiate communications, actions, and orders based on their own appraisal of the situation.

In order to make simulation effective, the participants' responses should be a realistic application of their own experiences and knowledge used in handling emergencies.

Positions That May Be Utilized During Simulation

Umpire - Director

1. In charge of all arrangements preceding exercise, during exercise, and during debriefing.
2. Determines reasonableness of actions taken by trainees and interprets these in control simulation.
3. Coordinates between members of the staff positions to maintain exercise objectives.
4. Determines appropriateness of possible emergency situation inputs.
5. May alter course of exercise through direction of trainees and/or simulator when it is necessary to adjust for apparent misjudgment of trainees.

Fire and Audio Simulation Operator

1. Programs spread of fire and increase of smoke conditions according to exercise instructions.
2. Increases or decreases effects according to directions of Umpire - Director.
3. Monitors audio simulation according to exercise instructions.
4. Contributes audio simulation according to advice of the Umpire - Director.
5. Monitors conditions of activities to advise Umpire - Director of developments that may affect the exercise functions.

Dispatcher - Record Keeper

1. Upon request of trainees, independently dispatches suppression resources listed as available in the exercise program instructions.
2. When requested by trainees, independently furnishes information on resources available, weather, etc., according to exercise program instructor and/or the Umpire - Director.
3. Maintains records of resources, assignments, roles, role players, and estimated times of arrival.
4. Advises proper individual of role events due to occur.

5. Monitors all simulated circuits and controls tape recorder (if used) for purposes of documenting chronology of events.

Role Players - Trainees

1. Act within the latitude indicated in exercise program instruction.
2. Upon request, furnish information in accordance with exercise program instructions.
3. Except as modified by specific input requirements, perform as would be expected for the roles that they are playing.
4. Contribute information requested based on known facts. If facts are not available, simulate information as reasonably as would be expected under emergency conditions.

   (Note: No "impossible" emergency situations should be contributed.)

Position Relationship

1. Always in accordance with "Span of Control" concepts.

Do's and Don'ts of Simulation

DO	DON'T
1. Use a representative cross section of typical occupancies.	1. Do not overwhelm the participants with extraneous information or problems.
2. Have all handout material ready.	2. Don't build the problem too fast.
3. Establish realistic timetables.	3. Don't overcrowd the simulation area.
4. Have the results correspond to the actions taken.	4. Do not embarrass the participants.
5. Teach one technique at a time.	5. Don't build in traps.
6. Build from simple to complex.	6. Don't use an unrealistic situation.
7. Use slides and diagrams of local problems when possible.	7. Don't escalate the problem beyond the control of the students.
8. Allow participants to analyze the exercise. They will probably find most of the errors that are made.	8. Don't concentrate on only one specific type of problem.
9. Allow participant to become familiar with the operation of the equipment before the exercise.	
10. Have sufficient number of facilitators to manipulate the equipment.	
11. Ultimately show success.	
12. Check out the equipment before the class.	

Critiques

After simulation has been used, a critique of the activities is normally held. Each role player is asked to report on his/her responses and actions and to explain why their decisions or theories were applicable. Class members are allowed to participate in the critique in a question and answer session. The course instructor will normally evaluate the entire problem. Sometimes radio communications are recorded and played back to substantiate and evaluate decisions made, orders given, basic radio procedures and other pertinent facts. Remember, critiques are constructive methods of learning. Nothing is learned by arguing.

Simulation Fact Sheet

During an emergency response, basic information/data is readily available to the response personnel. In simulation, however, much of the information must be provided by the instructor or dispatcher, or gleaned from the visual display.

By completing this fact sheet, as the information becomes available, you create a usable reference for use during the exercise.

Note: The exercise may not involve all of the information cited below.

1. Nature of Emergency: ______________________________
2. Address: ______________________________
3. Type of Occupancy: ______________________________
4. Level of Response (response info): ______________________________
5. Day/Date/Time of Report: ______________________________
6. Weather Conditions ______________________________
7. Additional Info from Dispatcher on R.P.: ______________________________

	Engines	Trucks	Squads	V.F.C.	Officers	Water Tenders
1st Alarm						
2nd Alarm						
3rd Alarm						

Rating Simulation Exercises

As per the instructor's directions, you will utilize one of the two rating sheets that follow. The information below provides a brief recap of some of the management items necessary for exercising successful fire command.

An Incident Commander should:

- Remember the fundamentals of communication.
- Think in terms of broad objectives and give orders in those terms.
- Teach and expect subordinate officers to accept and respond to orders given in broad terms.
- Remember that strategy is an overall plan by which the emergency is handled.
- Remember that tactics are those efforts directed toward the accomplishment of the plan.
- Maintain a concise thought process and leave details to the firefighters.
- Remember large fires are somewhat like small ones, expect that they need more personnel and equipment and take longer to extinguish.
- Remember that large fires dictate the need for more fire flow and that it must be applied at greater distances.
- Assign control criteria based on objectives. These objectives should have the dimensions of quantity, quality, and time.
- Encourage companies to stay together in the sector assigned.
- Encourage company officers to use judgment and assume a command role if need be.
- Bear in mind the specific objectives that may need to be met:
    - Rescue of occupants
    - Life safety to firefighters
    - Exposure protection
    - Confinement
    - Extinguishment
    - Overhaul
    - Ventilation
    - Salvage
- Avoid "tunnel vision" in overseeing operations.
- Consider the following factors when establishing objectives
    - Type of construction

- Size and direction of travel of the fire
- Nature of the occupancy
- Safety of the citizens and firefighters
- Potential of the emergency
- Priorities of operations needed
- Weather, traffic, water supply
- Manpower, equipment and resources

- ❑ Set up a command post and make its location known to all subordinate officers.
- ❑ Establish a strong command structure and maintain unity of command.
- ❑ If the present deployment is not correct, re-deploy companies as needed.

Simulation Rating Sheets

Rating Sheet #1

I. Size-Up
1. Evaluation of the situation
2. Clarity of initial radio report
3. Notification of mutual aid - A.R. - Chief Officers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Poor Average Above Average

Comments: ______________________________

____

II. Tactics and Strategy
1. Rescue
2. Exposures (Internal and External)
3. Placement of hose lines, ladders, equipment
4. Ventilation

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Poor Average Above Average

Comments: ______________________________

____

III. Use of Apparatus and Personnel
1. Realistic use of resources
2. Incoming units
3. Assignment of officers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Poor Average Above Average

Comments: ______________________________

____

IV. Control
1. Self control
2. Control of the problem

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Poor Average Above Average

Comments: ______________________________

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Rater: ______________________________ Incident Commander: ______________________

Rating Sheet #2

During this exercise, the Incident Commander will be rated on specific characteristics important in controlling an emergency suppression situation. You, as the rater, are asked to make specific comments as necessary on each of the areas and indicate the level of performance.

	Rating			
Incident Commander's Specific Area of Performance	**Below Average**	**Average**	**Good**	**Excellent**
1. Making an initial size-up				
2. Giving clear, concise orders that contain an objective				
3. Tactically deploying personnel and equipment to the best advantage				
4. Establishing objectives based on time, quality and/or quantity				
5. Effectively coordinating the emergency situation with all units				
6. Effectively setting up fireground organization utilizing ICS principles				
7. Effectively communicating with other personnel				
8. Thinking in terms of broad objectives utilizing good management techniques				
9. Overall performance				

Comments: ____

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Rater: ____

Appendix B: Case Studies

Skull Sessions

Fifteen case studies may be used by the instructor during the "simulation" exercises. Instructions for their use will be provided. Each case study consists of a description sheet and plot plan. Both are necessary for the student's use in completing each exercise.

Case Study #1: Structure Fire in a Single-Family Residence

Facts Known Prior to the Emergency

This is an ordinary single-family dwelling with a wood frame-stucco exterior and shake-shingle roof, located in a medium-income area. The home is about 20 years old, and the apartment house next door is less than 5. The house under construction on the other side is in the framing stage.

Information Upon Dispatch

A police officer reports by radio that he sees smoke from a residence at 110 San Rafael. He does not respond to further radio calls. Fire equipment is dispatched. The time is 1230 hours. The date is October 15.

Observed Upon Arrival

A large glow can be seen by the first-in company. Fire is first observed coming from the front door and the kitchen. The peaked roof in the living room area is well involved. A police officer is observed in the driveway trying to restrain an elderly woman who is visibly upset. An elderly man wrapped in a robe is standing across the street, but is not moving or talking. Several people are observed trying to remove vehicles from the apartment garages that face the alley. Wind speed and direction are not a factor.

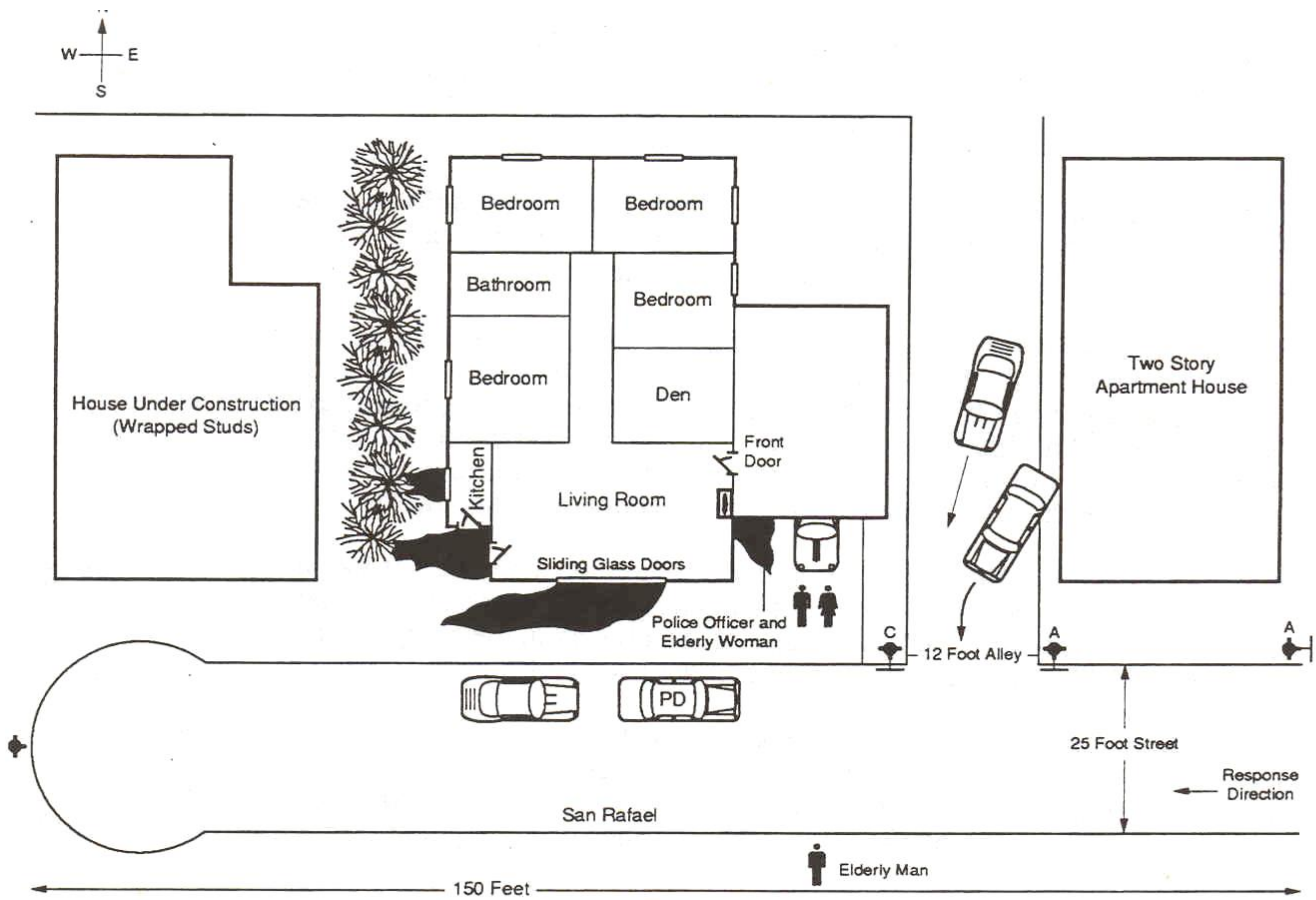
The fire is confined to the living room and kitchen at this time. It has not extended into the bedrooms, but they appear to be very hot and charged with smoke. The hall doors are ajar. The two occupants are art collectors, and many of the objects in the home are quite valuable. A cash box with over $1,000 in small bills is found in the back bedroom.

While you were making your call, the bushes located at the west end of the house ignited. They are a type of eucalyptus and burn freely. The vehicles exiting from the garage get involved in a slight fender bender while trying to avoid colliding with the fire equipment. The man who is standing on the other side of the street, who is one of the occupants, faints from shock after control is achieved.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack

5. Placement of equipment and command personnel
6. Potential for escalation



Case Study #2: Smoke in a Single-Family Residence

Facts Known Prior to the Emergency

This is a typical wood frame-stucco residence with a shake-shingle roof. It is about 15 years old and was built as a single custom home, not as a part of a tract. The occupants recently remodeled the house and added a new patio roof.

Information Upon Dispatch

You are responding to a smoke investigation. The occupant could smell smoke, but could not locate it. The time is 1400 hours. The date is December 12.

Observed Upon Arrival

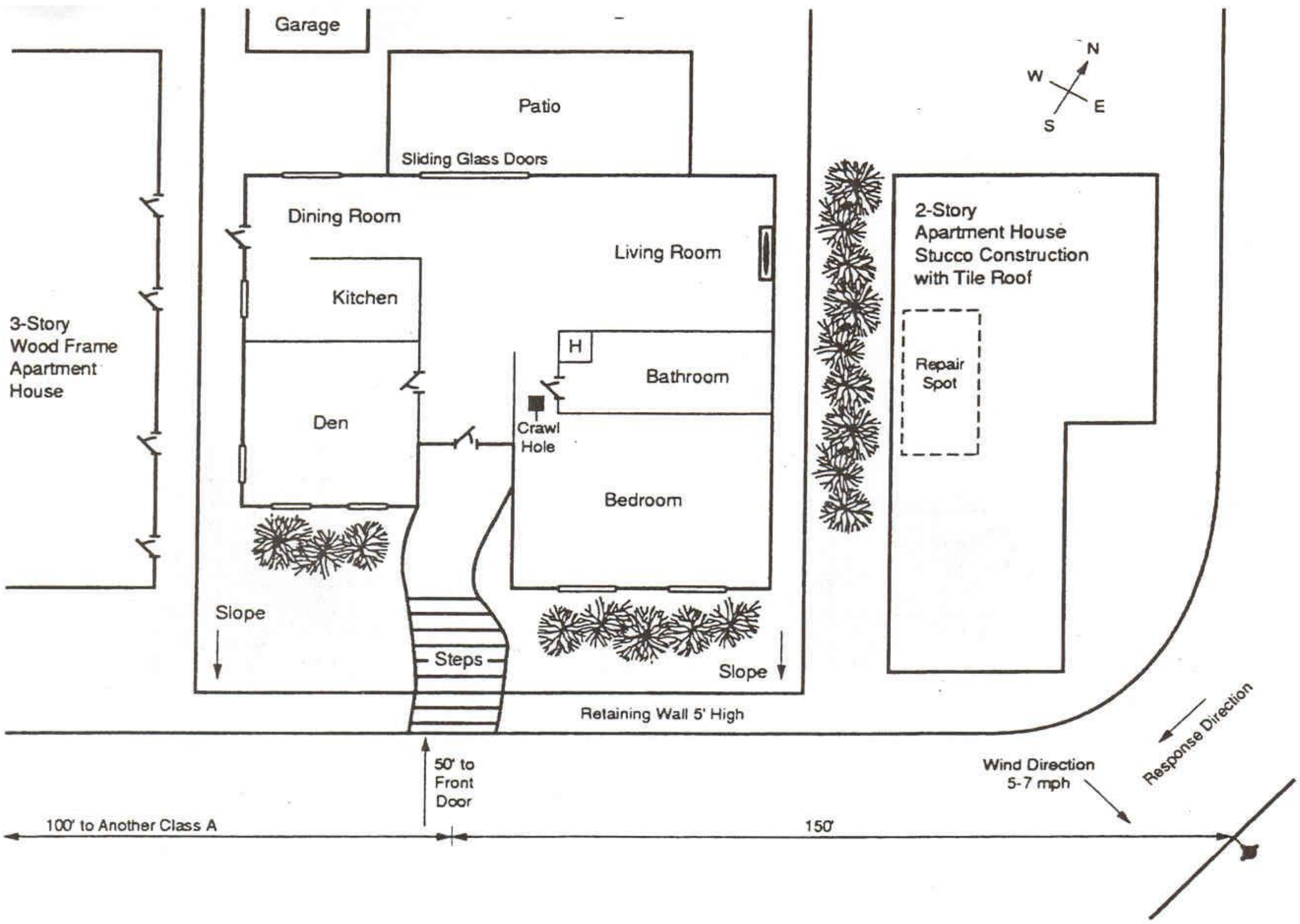
Smoke is seen coming out from under the shingles on the front of the roof. The smoke is whitish and not very thick. The occupants are standing in the door, beckoning you to come up the walkway. They do not appear to be too upset. Just as you start up the steps, you hear a loud yell from the woman. The message is indistinguishable. She exits from the front door, and a grayish-white smoke follows her. You can see from the door all the way into the living room, which appears clear. The hall doors are ajar. The smoke seems to be coming from an area to the right of the entrance hall.

The fire is in the attic, the result of a recently repaired heating vent not being properly restored. The fire is burning freely in the attic and has dropped burning material down onto the hallway carpet. The two occupants are art collectors, and the house is richly furnished with antique furniture. The repair in the next building over is a potential exposure problem when ventilating. It is merely a covering of tarpaper over a plywood roof. The tiles have been removed.

Laddering this house is difficult in the front because of the slope. The roof is weak in spots and a person can put his foot through it if he is not careful.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation


Garage
Patio
Sliding Glass Doors
Dining Room
Living Room
Kitchen
3-Story
Wood Frame
Apartment
House
H
Bathroom
Den
Crawl
Hole
Bedroom
2-Story
Apartment House
Stucco Construction
with Tile Roof
Repair
Spot
N
W
E
S
Slope
Steps
Slope
Retaining Wall 5' High
50' to
Front
Door
Wind Direction
5-7 mph
Response Direction
100' to Another Class A
150'

Case Study #3: Structure Fire in a Single-Family Residence

Facts Known Prior to the Emergency

This is an area of one-family dwellings. Most are wood frame with some brickwork. The roofs are mixed tile or shake. The area is upper income and abuts a golf course.

Information Upon Dispatch

A vehicle pulls into the fire station and the driver reports that a house is burning "right down the street." He offers to guide you because he does not know the address. The time is 1209 hours. The date is September 27.

Observed Upon Arrival

You can see smoke as soon as you leave the station. As you round the curve at the end of the block, you observe fire coming out of what appears to be a sliding glass door. Smoke is not coming from any other window or door yet. Broken glass is lying all over the sidewalk. A completely nude man is bleeding from numerous cuts and scratches. He is babbling incoherently and smells of liquor. A large crowd is gathering, and one civilian is attempting to raise the garage door. He is shouting something about a valuable car in the garage. Suddenly a small foreign car pulls up and a young woman jumps out of the car, running rapidly toward the house.

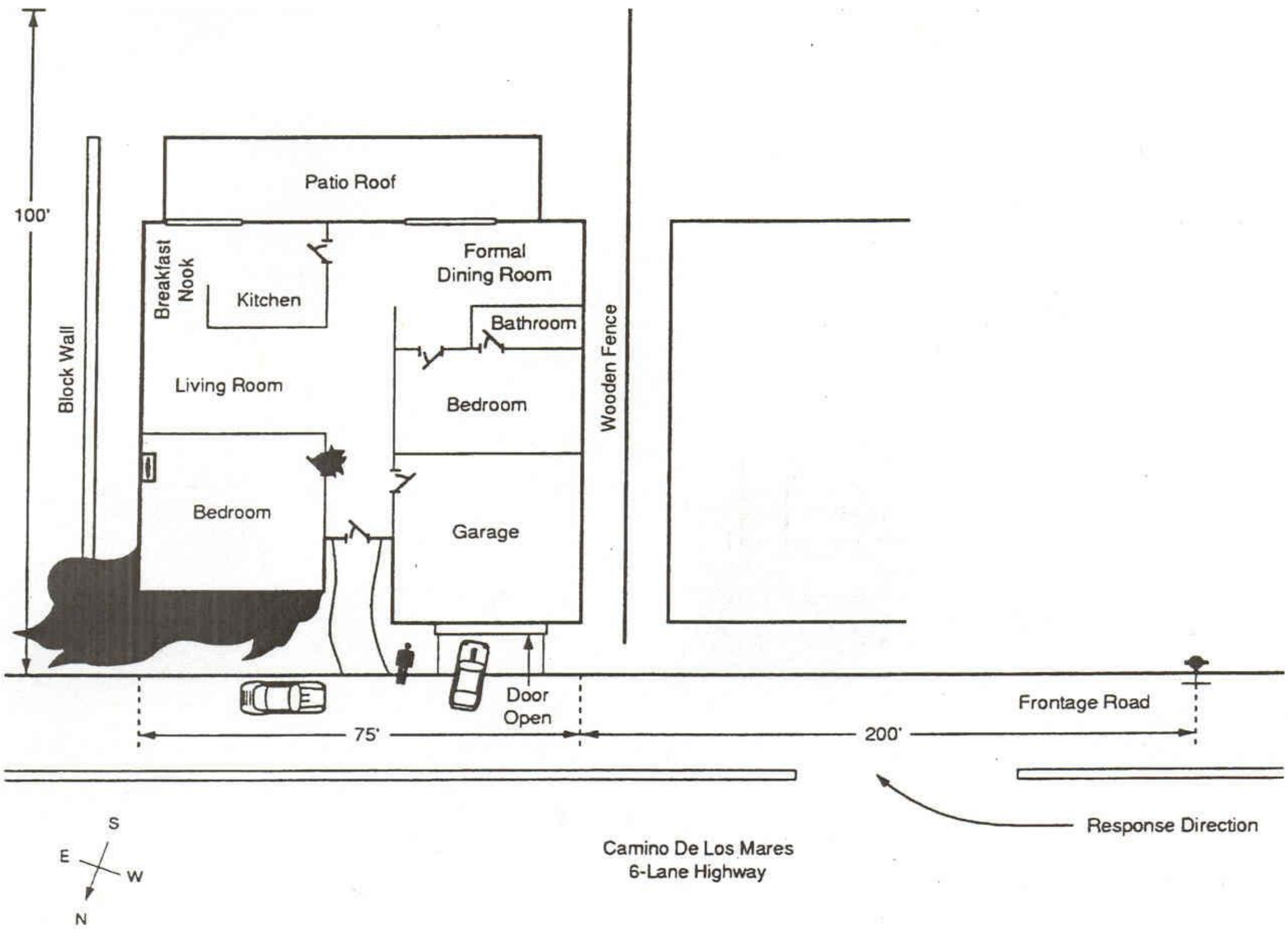
The front door is locked and has to be forced open. The fire is confined to the bedroom at this point, but is reaching out into the hallway. There is no attic. The victim is, as might be guessed, intoxicated. The fire actually started in the wall from a short in the electrical system. It then spread to the bed. The victim was awakened by one of his dogs. He subsequently threw a chair through the plate-glass door and exited that way. The roof is burning freely, and the house is completely charged with smoke. Visibility is zero. The two dogs are found dead in the living room.

The vehicle in the garage is a brand new Porsche. The girl who arrives runs right by the victim and attempts to enter the house. She starts screaming and crying that her mother may be in there. The mother is not there, in reality, but arrives on-scene about 45 minutes later. Piles of rocks and debris alongside the house and garage make for treacherous walking in this area. The roof fire gets all the way over the living room.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed

4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation



Case Study #4: Structure Fire in a Garage

Facts Known Prior to the Emergency

This condominium tract is about 9 years old. It is wood frame with a stucco exterior and an asphalt-shingle roof. The occupants are known to be predominantly middle class. It is also well known that there are access problems into the garage areas and that some of the occupants are engaged in illegal second businesses (such as car repair and car spray-painting) in their garages.

Information Upon Dispatch

Reported structure fire, no details. The time is 1510 hours. The date is May 4.

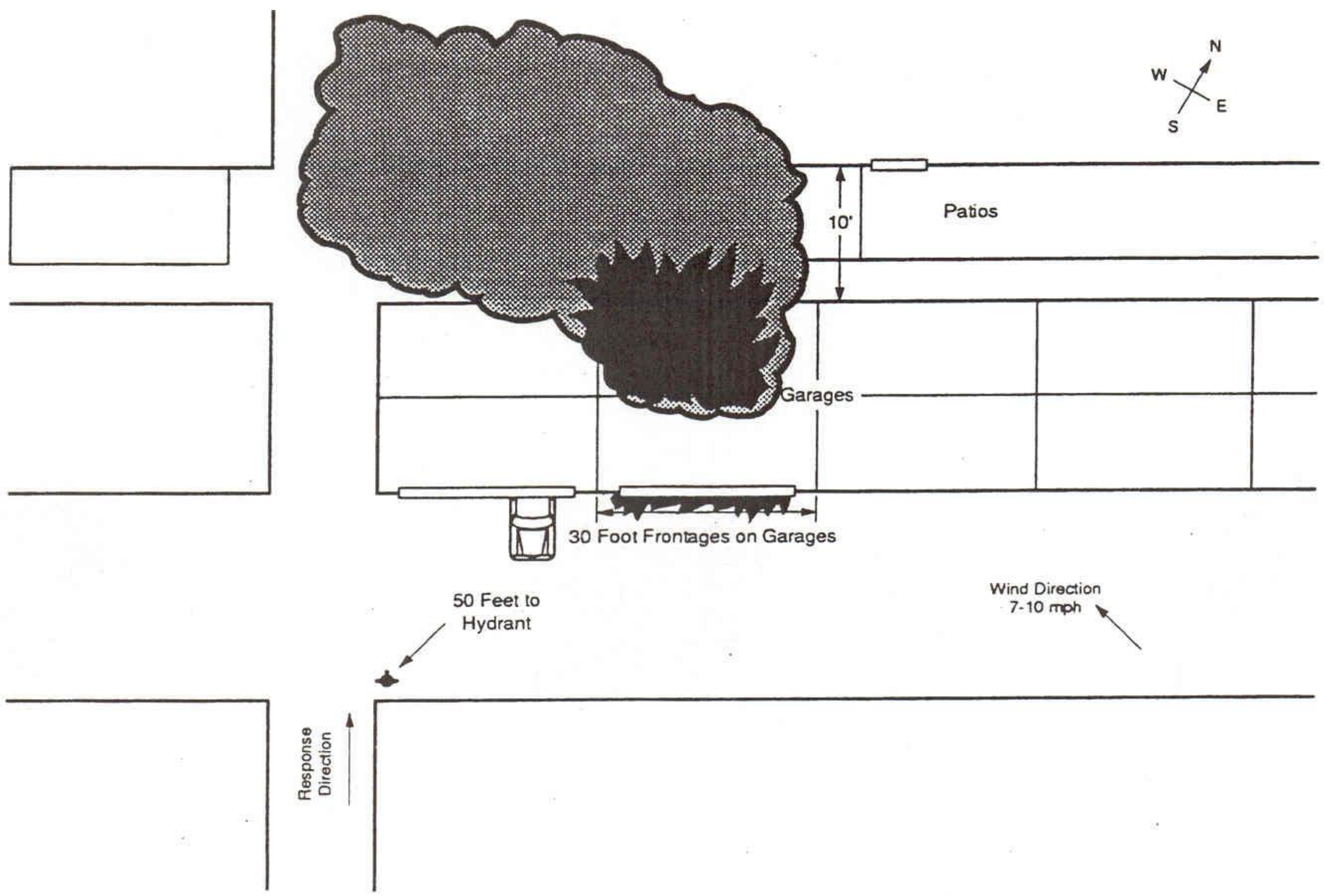
Observed Upon Arrival

A large column of smoke is visible. The roof of the garage is almost completely consumed by the time you get there. The door on the garage is down but is burned through in spots. A vehicle is half out of the garage next door. The column of flames is over the top of the two-story apartment building directly to the rear. The smoke is obscuring your vision of the apartment directly behind the garage. There is hardly anyone in the street. Just as you arrive at the scene the fire seems to intensify and a low "whump" comes from the involved garage. The "whump" later proves to be exploding aerosol cans.

The man who owns the garage manufacturers dune buggies inside. The garage contains 35 to 40 gallons of gasoline and a large number of magnesium wheels that react violently to water. The fire walls on both sides of the garage hold, but smoke gets into the interior of the second-floor condominium. The curtains in the kitchen begin to burn. There is no one home in that unit.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation



N
W
E
S
10'
Patios
Garages
30 Foot Frontages on Garages
50 Feet to
Hydrant
Wind Direction
7-10 mph
Response
Direction

Case Study #5: Structure Fire in a Condominium

Facts Known Prior to the Emergency

The Monte Vista Condominiums are approximately 10 years old. They are occupied mostly by elderly people. The structures are wood frame and stucco, with mixed roof types. The homeowners' association in the area is known to be hostile to both the police and fire departments because of recent tax increases for these services-

Information Upon Dispatch

A police officer on the scene has reported that the condominium at 737 Monte Vista is well involved. The time is 0430 hours. The date is June 15.

Observed Upon Arrival

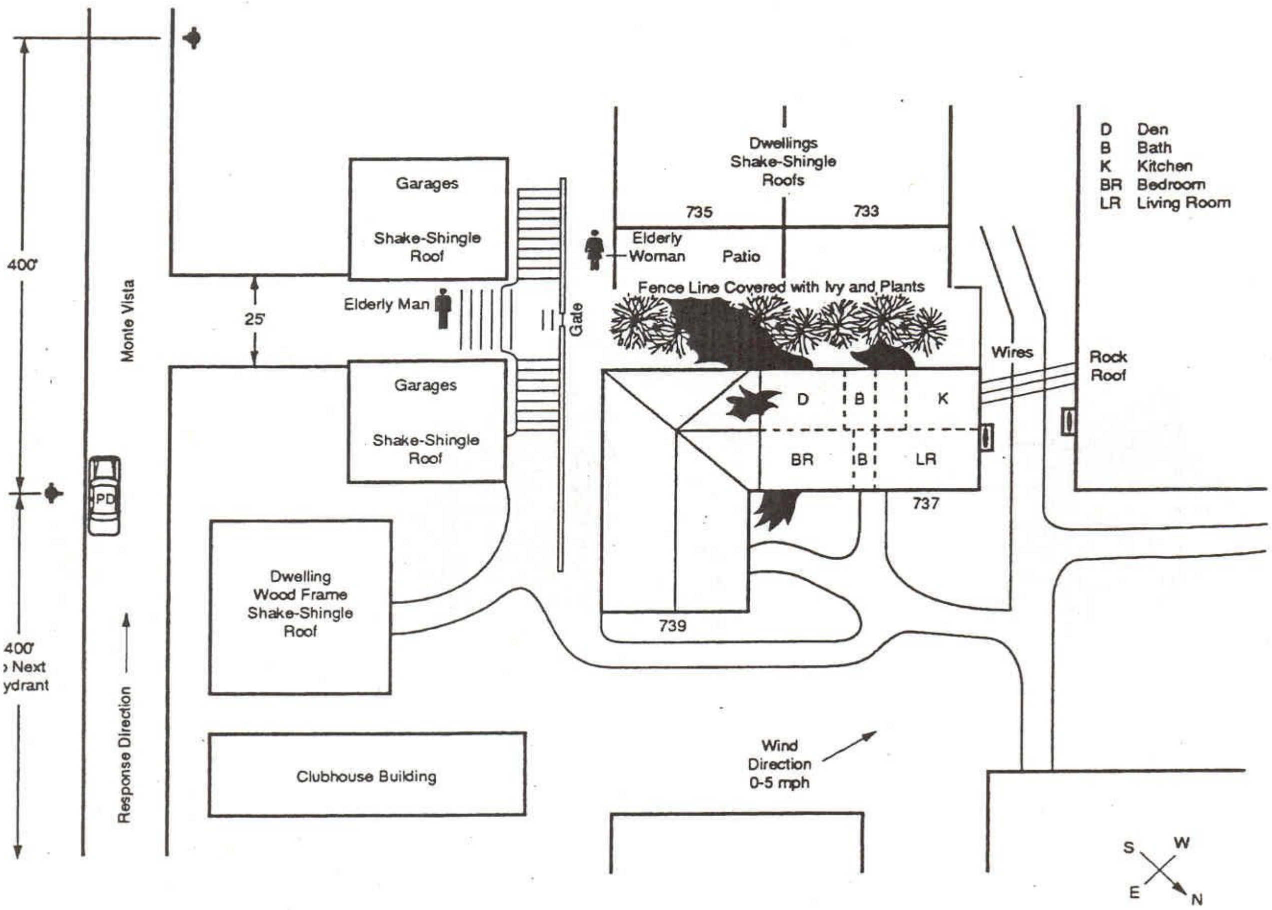
You can see the glow of the fire as soon as you leave the station. A large crowd greets you upon arrival. They are agitated and accuse you of a delayed response. A police car is parked in front of a hydrant, but no police officer is in sight. One elderly man is seen walking down between garages. He is dressed in a bathrobe, has an armful of papers, and appears dazed. Fire is coming from three windows and has broken through the roof. The fence, patio roof, and bushes between 737 and 735 are burning freely. An elderly woman is observed at the gate leading to the steps. She has some garden furniture. It is hung up on the gate and she is trying to free it.

There is a considerable delay of alarm on this fire. The elderly man in the bathrobe later informs firefighters that he had gone to bed at 2200 hours and woke at 2300 hours to the smell of smoke. He had extinguished a fire in the sofa and went back to bed. Smoke is showing inside the bedroom of 739 because of poor construction of the separation wall. The bushes are burning freely, and the entire roof of 737 is burning within 2 to 3 minutes of arrival. The den, bathroom, and kitchen suffer the most structural damage. The fire burns through the wires outside the kitchen and live wires drop onto the sidewalk in that area. Because gas is fed into these apartments from overhead, the gas line begins to leak in the attic above the entrance to the bathroom. The occupant is a retired engineer. He advises fire fighters that his files on the family genealogy are in the bedroom. The police officer is found trying to evacuate people from 733 and 735. The female occupant of 735 becomes distraught and has to be hospitalized.

How Would You Deal With This Problem?

1. Report on conditions

2. Primary objectives
3. Resources needed
4. Plan of attack



5. Placement of equipment and command personnel
6. Potential for escalation

Case Study #6: Structure Fire in a County Club

Facts Known Prior to the Emergency

The country club is brand new. It is a two-story wood-frame building with a drop ceiling about 24 inches deep. The roof has a parapet 6 feet deep that that creates the appearance of being tile. The flat surface is hot-mopped. The facility is city-owned, but operates with a lease. The building is not equipped with fire sprinklers.

Information Upon Dispatch

You are responding to a reported structure fire. The information is from an employee of the clubhouse. The time is 1320 hours. The date is March 7.

Observed Upon Arrival

Large volumes of jet-black smoke are boiling up over the parapet. The smoke almost obscures the entire southeast corner of the building. There are not many cars in the parking lot. A busboy from the restaurant inside advises you that a group is meeting in the banquet room and has not exited. You do not observe any smoke at all upon entering the building. The place seems to be doing business as usual. Golfers in the lounge and restaurant do not appear alarmed.

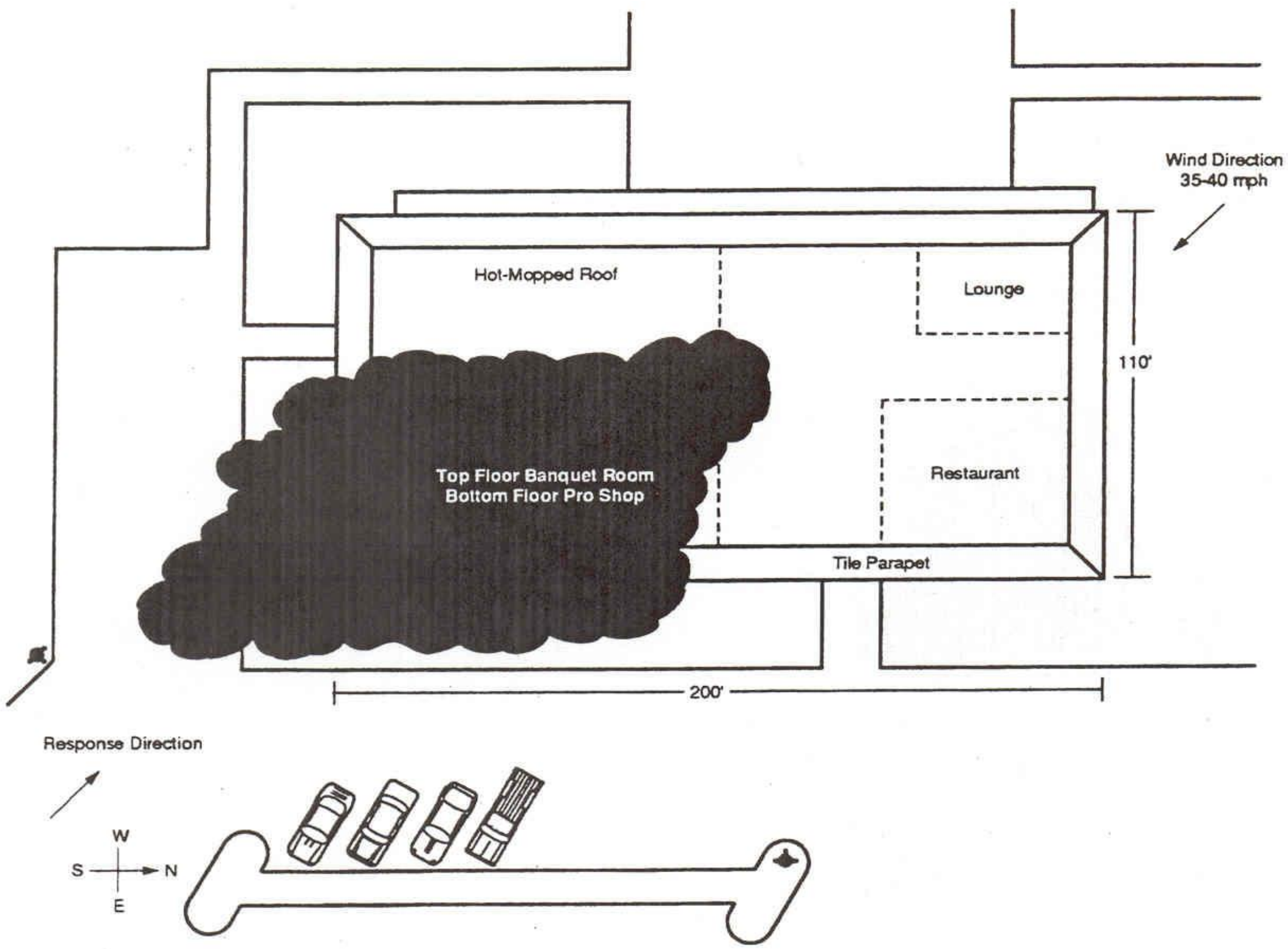
The banquet room is full of police chiefs. It is their monthly meeting, and they regard the evacuation order as a practical joke on the part of the local fire chief. They were not convinced until fire fighters started poking holes in the drop ceiling.

The fire is actually on the roof. It was started by a hot water heater. Its flame was inverted by the wind, and the tarpaper ignited. It burned across the roof and into the dead space behind the parapet. Eventually it wound up in the small dead space above the banquet room ceiling, where it reversed direction and burned back toward the lounge area. Cross ventilation is almost impossible in the structure because there are no windows on two sides. The other windows face the course and are inoperable. The owners are concerned about water damage to clothing in the pro shop below.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel

6. Potential for escalation



Case Study #7: Structure Fire in a Fiberglass Manufacturing Plant

Facts Known Prior to the Emergency

This plant manufactures fiberglass shower stalls and restrooms for use at construction sites. It uses all the chemicals associated with fiberglass including acetone, methyl ethyl ketone, and resin. The facility uses an air-powered "chopper" gun to apply the gas and resin. It has a mediocre fire prevention record and is known to use unskilled labor.

Information Upon Dispatch

The smoke column is first observed by fire companies. They dispatch themselves. The time is 1500 hours. The date is June 12.

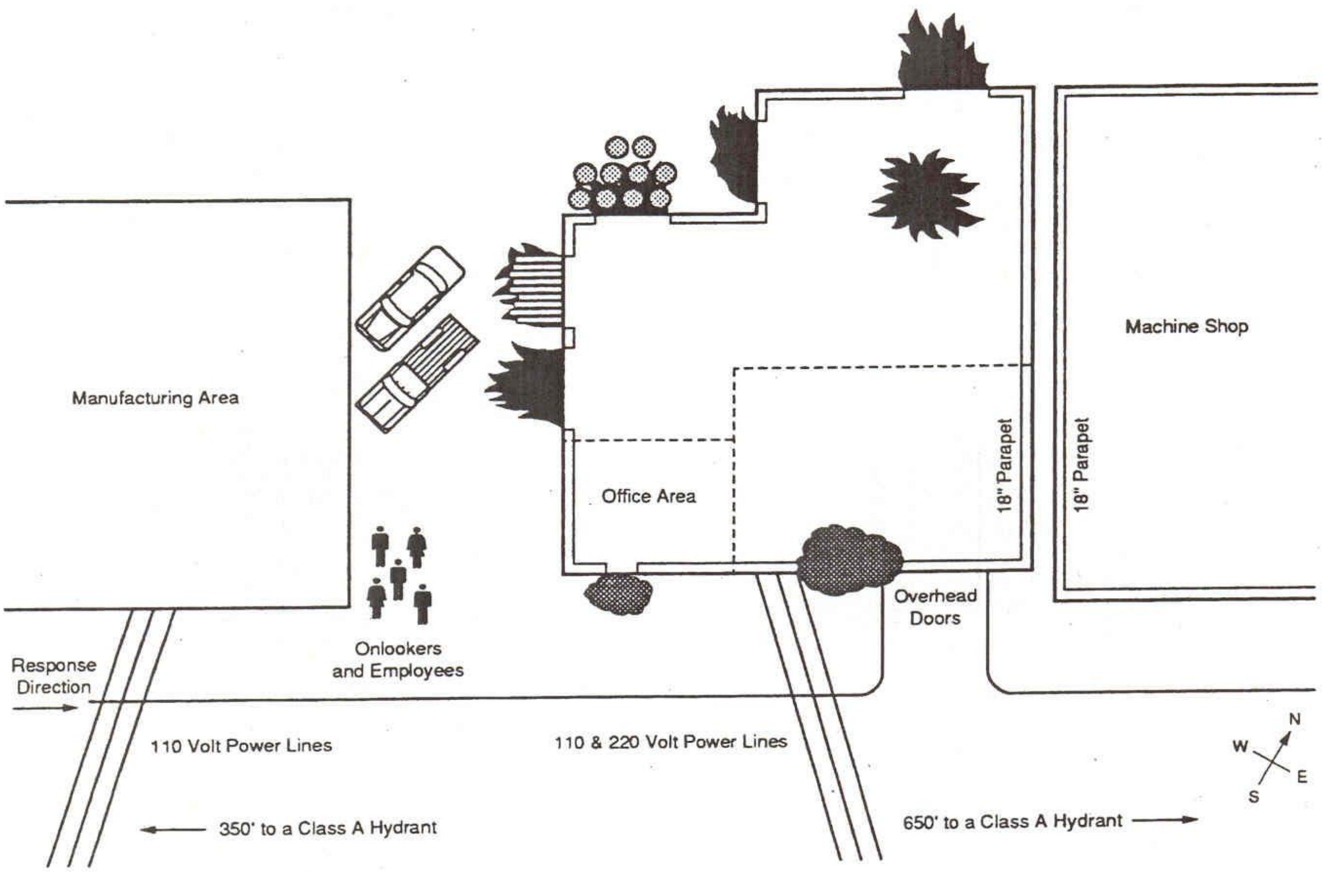
Observed Upon Arrival

Large volumes of thick, black smoke are rising from the structure straight up into the air. Fire has broken through the roof in the rear of the building. Thick smoke, but no fire, can be observed at the rear of the structure. Flame is impinging on the tops of the second row of drums. A stack of lumber under the window is burning freely. Several trucks and cars are parked next to the side access area. What appear to be groups of employees are clustered against the building next door.

The drums in the rear are a real problem because they are only partially full of their products, acetone, and resin. The wires above the street burn through and drop onto the street. The fire is very hard to knock down in the rear of the building because the occupants had not cleaned up the fiberglass debris for several weeks. The building is a total loss.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation


Manufacturing Area
Office Area
Machine Shop
18" Parapet
18" Parapet
Overhead Doors
Onlookers and Employees
Response Direction
110 Volt Power Lines
110 & 220 Volt Power Lines
350' to a Class A Hydrant
650' to a Class A Hydrant
N
W
E
S

Case Study #8: Explosion and Fire at a Chemical Plant

Facts Known Prior to the Emergency

The El Blanko Chemical Plant redistills solvents after industrial use. The building is of concrete tilt-up construction with a wood-joisted plywood-tarpaper roof. The entire area is primarily industrial with some mixed residential occupancies. The owner is a well-known local chemist. The building is sprinklered.

Information Upon Dispatch

The dispatcher receives a report of an explosion followed by fire at the plant. He reports numerous follow-up phone calls. The time is 1516 hours. The date is April 4.

Observed Upon Arrival

An apparent explosion has destroyed the roof of the building. One tilt-up section is lying on the access roadway. All the walls of the plant are bulging. All other sections of the building have shattered glass, broken signs, etc. The main explosion are is involved in fire with its contents and structural members lying in huge piles and burning freely. The sprinkler bell is ringing loudly, but it is obvious that the piping is destroyed. Large volumes of water are running down the access roadways. Wires are down and the natural gas cannot be shut-off because of damage to the meter. There are two injured workers lying in the street, which is filled with people, many cut from broken glass. Police are on-scene.

The explosion was caused by a runaway reaction of the distillation equipment. It destroyed the sprinkler system.

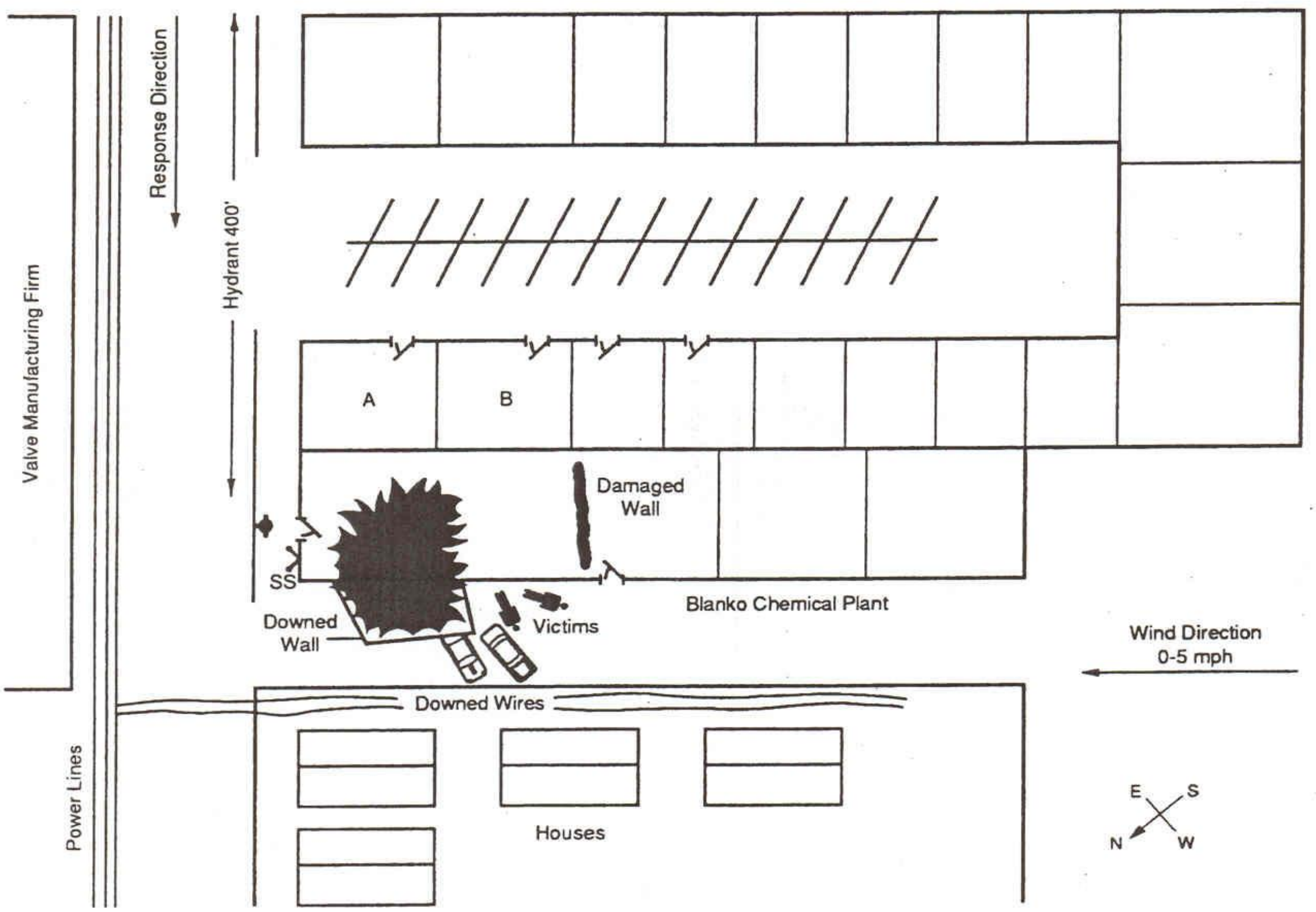
The plant is still full of drums containing solvents and chemicals. Identification of the chemicals is made difficult because of the fire damage and debris. The number of injuries is not as large as it first appeared. Only six people required medical aid. A body, however, was later found under the wall that had fallen.

The fire did not get into Unit A or B, but did get beyond the damaged wall and into other areas of the chemical plant.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack

5. Placement of equipment and command personnel
6. Potential for escalation



Case Study #9: Structure Fire in a Warehouse

Facts Known Prior to the Emergency

The occupancy is a glass jar manufacturing company. The construction type is concrete block wall on three sides. The roof is steel truss covered with plywood and tarpaper. The building is fronted with frame-stucco. It is only partially equipped with fire sprinklers. The company uses a night watchman service and the usual shift of workers is about 100. There is no fire brigade. The available fire flow is 10,000 gpm.

Information Upon Dispatch

The dispatcher notifies you of the alarm, which came from the night security. He reports numerous calls from the area. All reports indicate a very bad fire. The time is 1913 hours. The date is October 29.

Observed Upon Arrival

Prior to arrival, you can see large volumes of smoke. Upon rounding Florence and Roseberry, you can see that the building has ventilated itself. Warehouse Section A is involved. The sprinkler system alarm is not ringing. There is a large crowd, but no one offers you information or identifies themselves as employees. The factory section contains a bottle-making machine that takes at least 30 minutes to shutdown. It is not involved yet. The rated fire doors between all sections of the warehouse cannot be readily observed. The crowd and traffic attracted by the fire continue to grow.

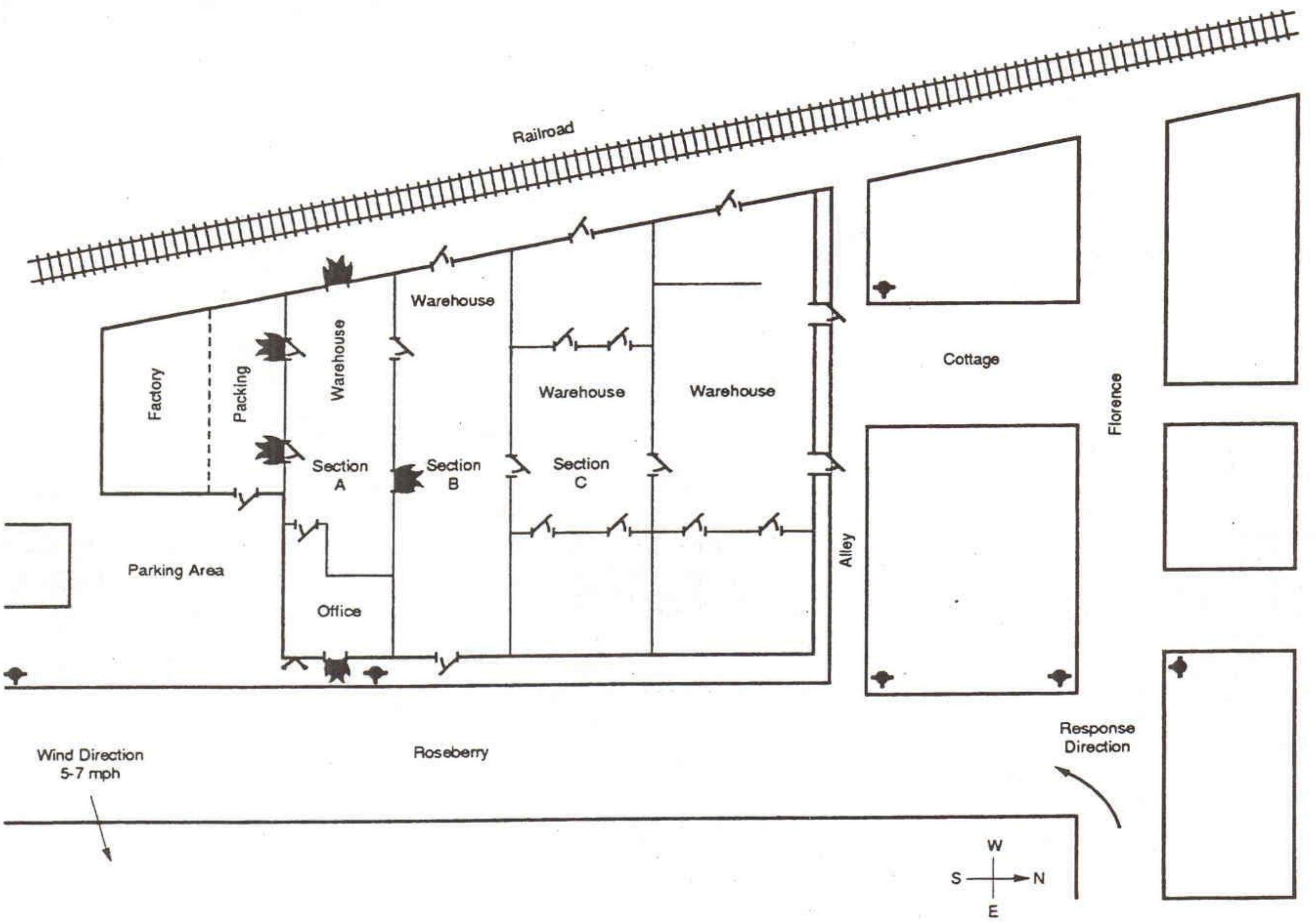
The biggest problem is keeping the fire out of the glass-making equipment, which is extremely expensive. The equipment requires very long shutdown and startup times. The sprinkler system was working. However, the fire was set by an arsonist and quickly overwhelmed the sprinkler system.

The fire eventually required a 5,000 gpm applied fire flow for 80 minutes (450,000 gallons). The concentrated fuel load and high values make this loss quite severe, about $350,000.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel

6. Potential for escalation



Case Study #10: Leaking Gas near an Antique Store

Facts Known Prior to the Emergency

The area is hilly and contains mixed commercial and residential occupancies. The antique store has an excellent inspection record, but the living quarters upstairs are not routinely checked. The usual occupants are military personnel from a nearby base and their dependents.

Information Upon Dispatch

You are dispatched as a single-engine response to a smell of gas in the area. There are no other details. The time is 1930 hours. The date is July 21.

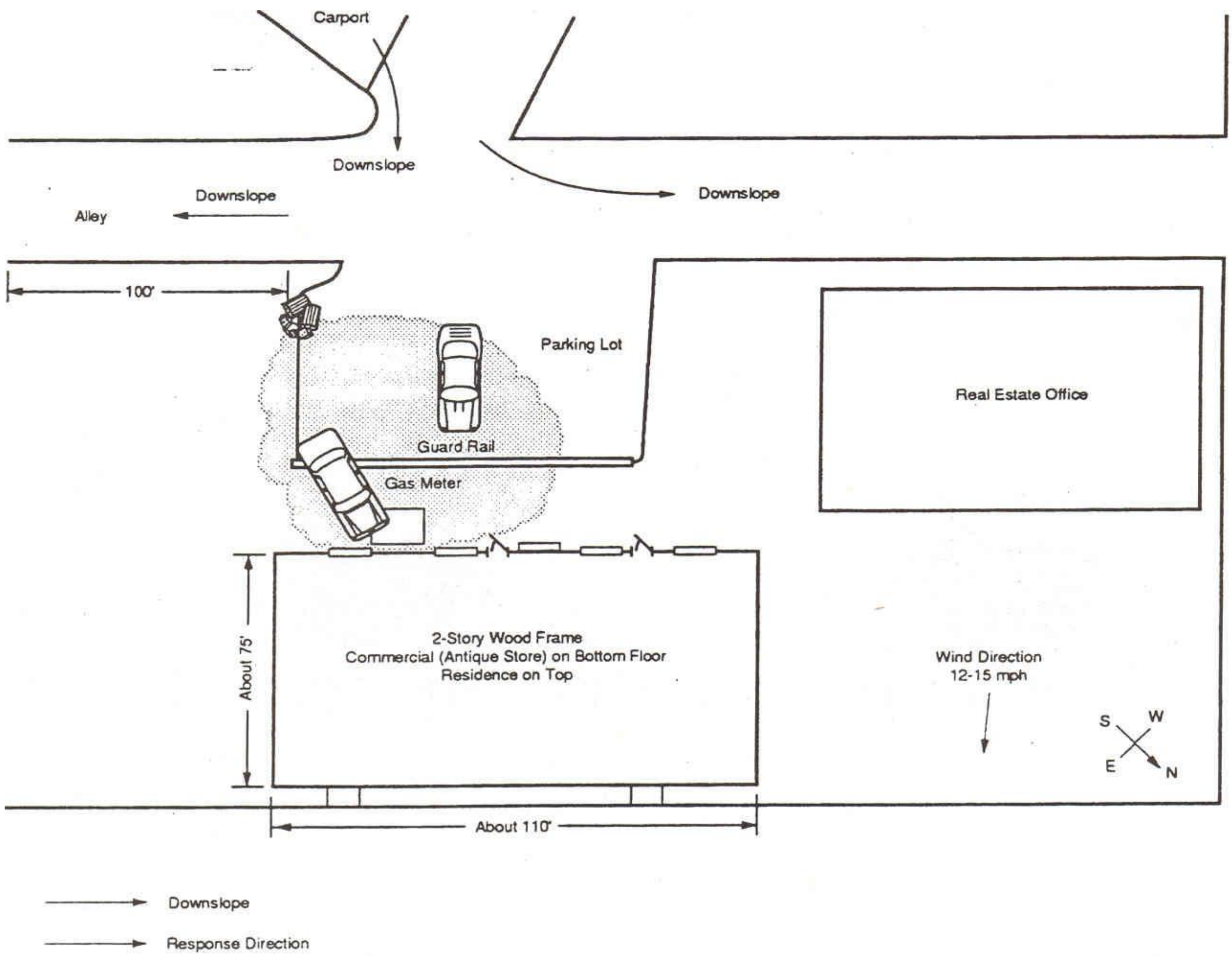
Observed Upon Arrival

A man waves you down in the street and tells you that a car has rolled down from the carport and knocked over a gas meter. You observe a late-model sedan that has jumped the guardrail and knocked the house meter off about 4 inches above the ground. The car's engine was not running. There is a very loud hissing sound. All windows of both floors of the building are wide open. The bystander advises you that he is not the owner of the vehicle and has not seen the owner. Several trashcans are scattered about, some jammed under the rear wheels of the car.

The antique store and apartments above are occupied and have to be evacuated. The entire structure is full of the odor of natural gas, but there is no clue as to its concentration. The gas meter's valve is broken off almost at ground level and a plug cannot be driven into it because the underside of the vehicle prohibits its placement. The car must be hauled off with a wrecker.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation



Carport
Downslope
Downslope
Alley
Downslope
100'
Parking Lot
Real Estate Office
Guard Rail
Gas Meter
About 75'
2-Story Wood Frame
Commercial (Antique Store) on Bottom Floor
Residence on Top
Wind Direction
12-15 mph
S
W
E
N
About 110'
Downslope
Response Direction

Case Study #11: Structure Fire in a Mobile Home

Facts Known Prior to the Emergency

The Seashore Colony Trailer Park is about 12 years old. Most of the trailers are used for vacation or weekend housing, but a few are occupied year round. The trailers are all 60 feet long and 20 feet wide. There is a limited access gate into the area. The park is bordered on one side by railroad tracks and on the other by the ocean.

Information Upon Dispatch

A police officer reports sighting smoke and fire over the bushes in the area of the trailer park. A few moments later, dispatch receives a confirming call of an explosion and fire. The time is 1530 hours. The date is January 8.

Observed Upon Arrival

Visibility from the road is limited because of trees, but a very large column of smoke and fire can be seen. Four house trailers are involved already. Two are burning; two are fully charged with smoke. A car is also burning. There is a strong smell of natural gas. Bubbles are forming in standing water on the street. The fire has ignited the trees along the road, and the overhead wires are burning and falling. A fireball exists at the end of trailer #91. There are a few occupants to be seen.

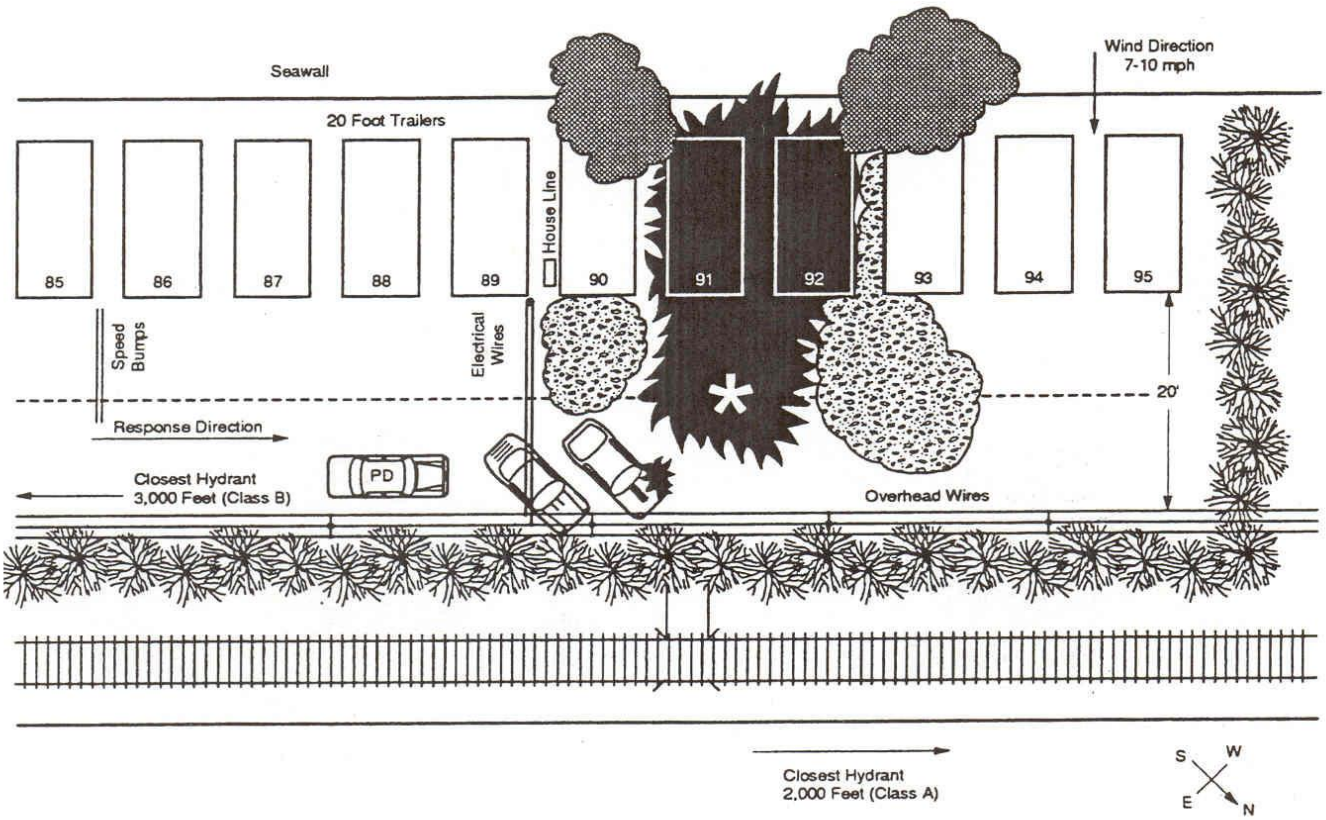
The two trailers on either side of #91 and #92 burst into flames almost instantly upon the arrival of the first-due company. Trailer #89 ignites with explosive force less than 2 minutes later. The overhead wires continue falling into the road. As lines are being laid to the fire, a passenger train approaches from the southeast. It is traveling at about 55 mph.

The fireball in the street cannot be extinguished. It is being caused by a leak in an 18 inch wide pressure main (600 psi) that is buried about 8 feet under the street. The gas is leaking upward and is actually burning through a hole about 29 inches in diameter in the asphalt (indicated by the asterisk [*] in the diagram on the following page). Trailer #94 starts to burn about 10 minutes after arrival. Flames are seen under the trailer and can be reached only by pulling off the skirt around the trailer. The fire is gas fed.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed

4. Plan of attack
5. Placement of equipment and command personnel



6. Potential for escalation

Case Study #12: Fires in Multiple Vehicles

Facts Known Prior to the Emergency

Main Street is a very busy 8-lane surface road that links the entire city's street network. It has a posted speed limit of 45 mph. Atom Street is a 6-lane surface road that feeds a junior college and funnels traffic into residential areas. The road surface is asphalt and is in excellent condition.

Information Upon Dispatch

You are responding to a reported vehicle fire in front of Kinney's Shoe Store. A loom-up can be seen for blocks. The time is 1845 hours. The date is September 11.

Observed Upon Arrival

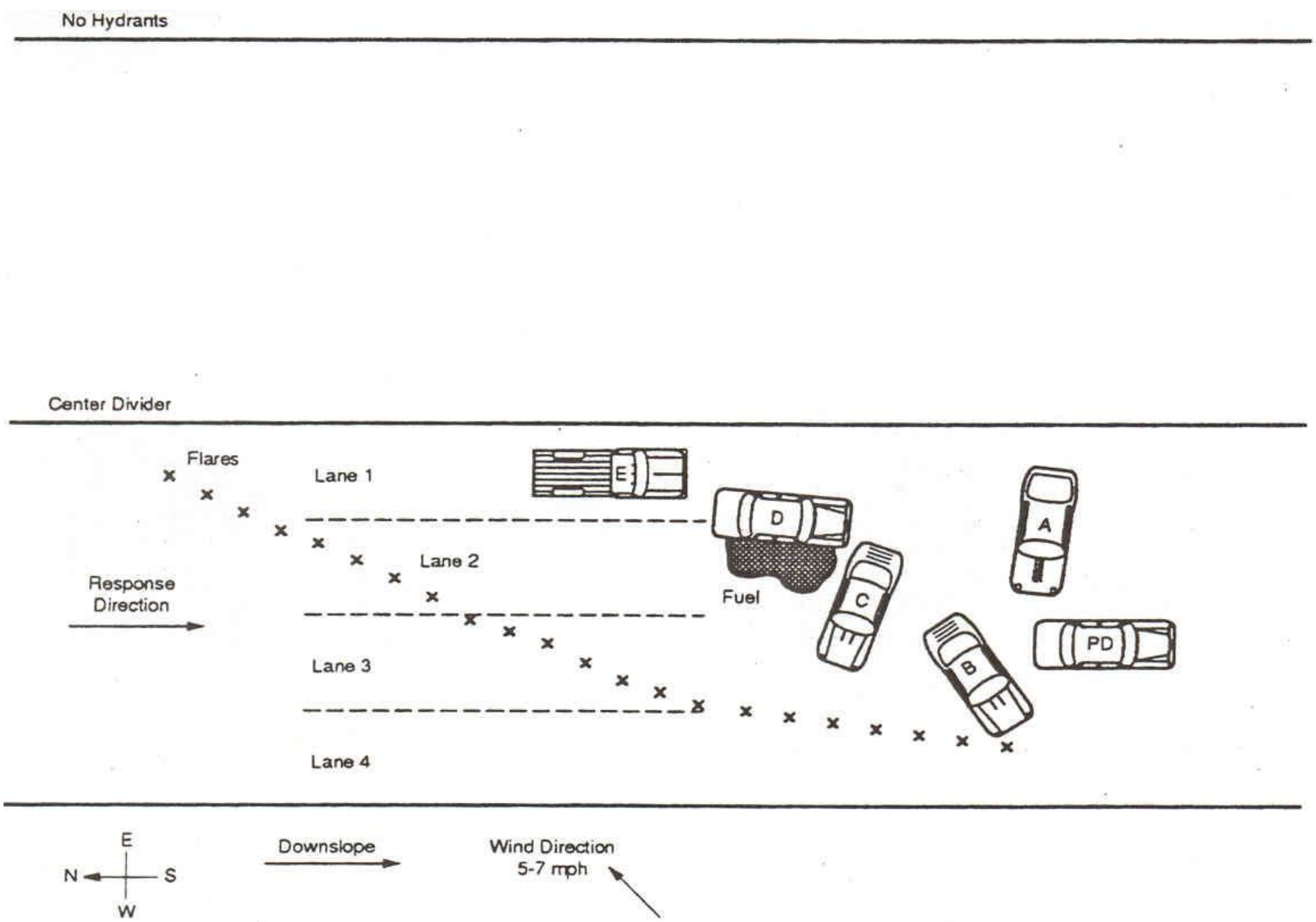
You see 6 passenger vehicles fully involved in fire. They are scattered all about and seem to have been struck from the rear. They are all in the left-turn pocket. At least five victims are observed lying either in the road or on the median strip. Most of them are being attended by civilians. A woman wearing what looks like a nurse's uniform advises you that Victim A is in critical condition. Gasoline is seen burning in the gutter against the median strip and flowing generally down slope. The first 4 vehicles in line are not burning, but they are damaged. Just as you pull up, the gas tank on the second vehicle from the front ruptures and intensifies the fire significantly.

This accident was caused by the last vehicle in line striking the stopped cars at a high rate of speed. Victim A was the driver at fault; he died on the scene. Other victims require medical aid and treatment at the scene.

Gasoline tanks exposed to high heat continue to rupture until fire streams are applied. Two other vehicles are ignited before the initial attack can be executed.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation


No Hydrants
Center Divider
Flares
Lane 1
Lane 2
Lane 3
Lane 4
Response Direction
E
D
Fuel
C
A
B
PD
E
N
S
W
Downslope
Wind Direction 5-7 mph

Case Study #13: Structure Fire in a Hotel

Facts Known Prior to the Emergency

This seven-story hotel was constructed in 1912. The upper five floors are residential. The bottom two floors are commercial. There are numerous elderly and low-income occupants, normally around 100 people. The building has a very bad inspection record, and the management is uncooperative. There is a dry standpipe. The open stairwells go from the basement to the fifth floor.

Information Upon Dispatch

The alarm came by telephone from a neighboring apartment house. The time is 1343 hours. The date is December 2.

Observed Upon Arrival

Fire is showing at the northern and eastern sections of the building. It appears to have gone through the roof already. Flames are coming from numerous windows. The second floor windows next to the fire escape are full of fire, cutting off escape. Fifteen to 20 people are shouting from windows or hanging from ledges. One man is seen hanging from a bed sheet from a third floor window. On the sixth floor, fire is showing at the northwest corner of the building. Approximately 10 people can be seen on the roof of the court area. The second through fifth floors of the south side of the court area have smoke showing, but not fire. People are using the fire escape there. Wind speed is negligible.

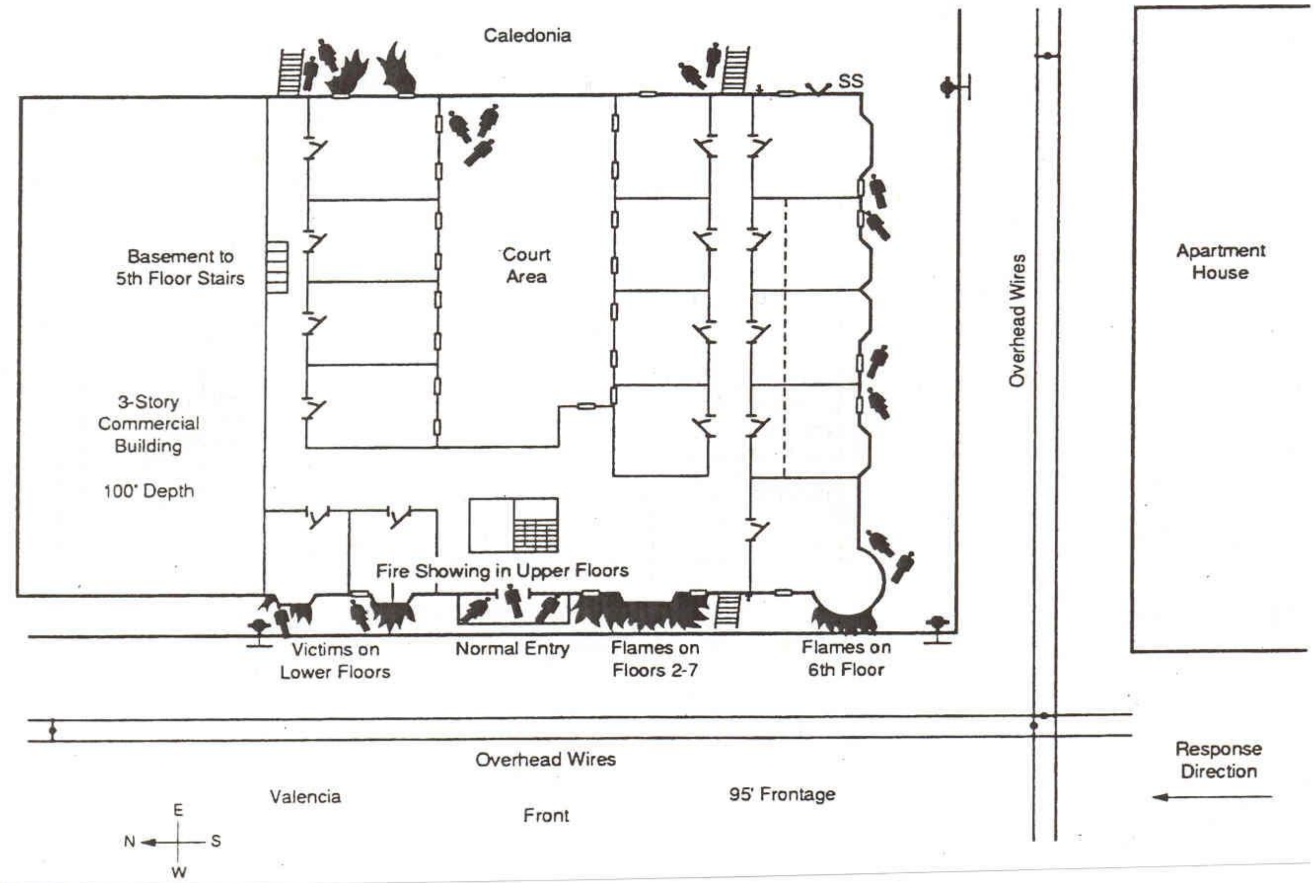
This fire was set by an arsonist. All of the floors on the north wing collapse soon after the arrival of the fire companies. Inside access to the fire is impeded when the stairway in the center of the building collapses, injuring several fire fighters. Eight fire fighters are burned by the sudden reversal of flames. The fire is so intense at the rear that entry is deemed impossible by one of the chief officers. Large embers begin to drive from the hotel and endanger other structures.

Rescue work involved the removal of 40 people. Eighteen others died.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack

5. Placement of equipment and command personnel
6. Potential for escalation



Case Study #14: Fire at a Tank Farm

Facts Known Prior to the Emergency

This is a bulk plant that refuels tank trucks. The front portion is a service station and the rear is a small tank farm. The tanks are all horizontal cylinders and contain a variety of fuels, mostly gasoline, solvents, and kerosene. The owner-manager has always kept his place up to code and has been very cooperative in the past.

Information Upon Dispatch

You are responding to a reported gasoline tanker fire. While en route you are informed that structures are also involved. It is 1400 hours on a hot July day.

Observed Upon Arrival

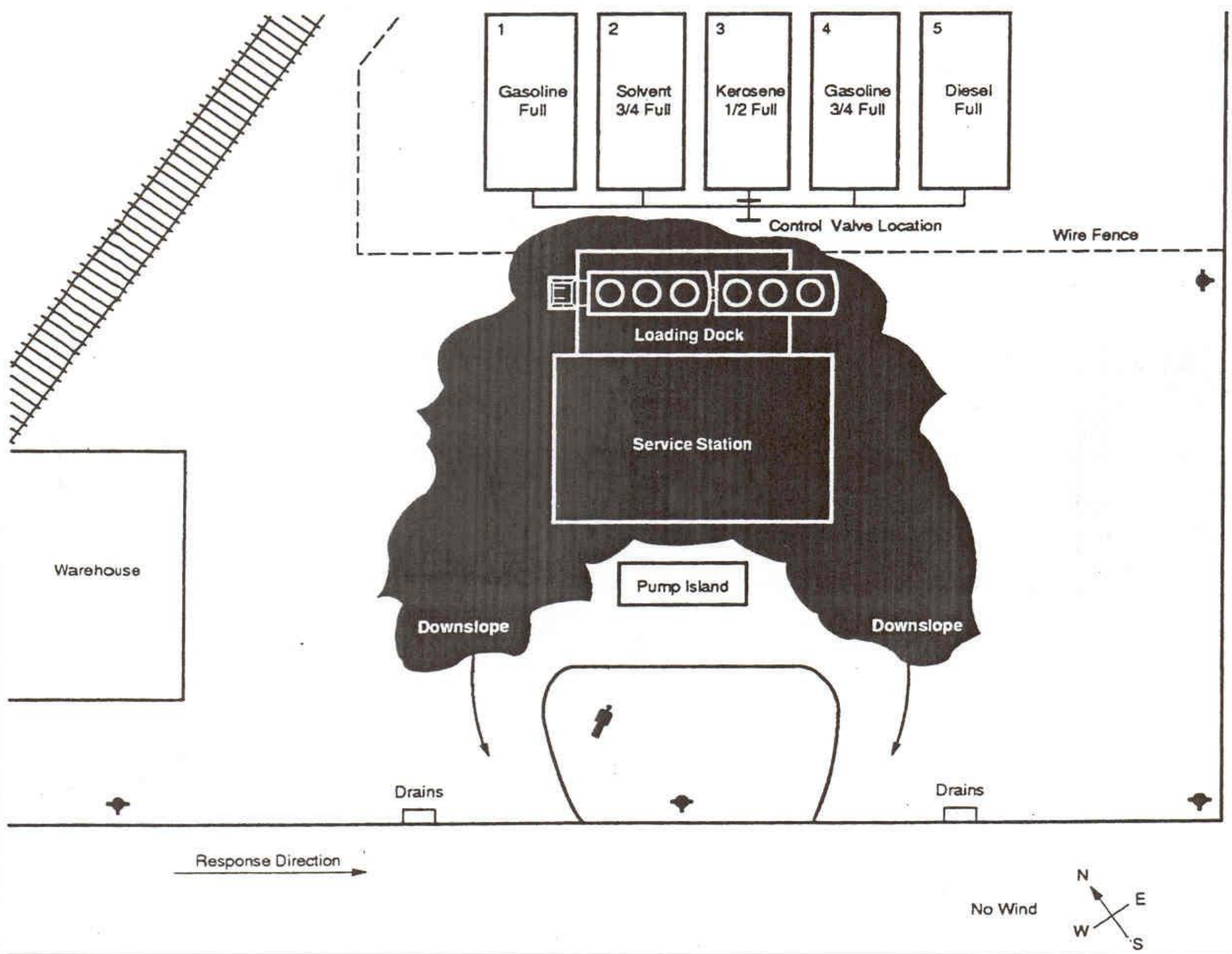
A large volume of fire is showing. The front end of a tank truck can be seen on the loading dock. A badly burned man is found in front of the building. The fire is obviously being fed more and more fuel as it starts to flow out of the loading dock area and straight down into the street. Storm drains are located to either side of the driveway. The flow is steady and moving down slope right at the pump island as you arrive. There are numerous onlookers, but they are driven back to the opposite site of the street because of the heat. Hydrants are available on both sides of the block.

The key to this incident is the fact that the fire is pushed back under the tanks. They overheat, and the subsequent rupture and rocketing of the tanks cause many deaths.

"Analysis of a Bulk Plant Fire," a film provided by the American Petroleum Institute, is highly recommended for a complete review of this incident.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives
3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel
6. Potential for escalation


1
Gasoline
Full
2
Solvent
3/4 Full
3
Kerosene
1/2 Full
4
Gasoline
3/4 Full
5
Diesel
Full
Control Valve Location
Wire Fence
Loading Dock
Service Station
Warehouse
Pump Island
Downslope
Downslope
Drains
Drains
Response Direction
No Wind
N
E
W
S

Case Study #15: Structure Fire in a High-rise Building

Facts Known Prior to the Emergency

The Golden Towers is an 18-story senior citizen's complex. All occupants are supposed to be ambulatory .The normal occupant load is 30 to 45 occupants per floor. It is of concrete and steel construction and was built three years ago. The building not equipped with fire sprinklers. There are two risers on the standpipe, a complete fire alarm system with an annunciator panel in the lobby, and a manager on duty 24 hours. The elevators are manufactured by Otis. The occupants are disdainful of evacuation and fire drills.

Information Upon Dispatch

There is a call from the manager. Fire alarms have been pulled on the seventh through eleventh floors. This is followed by a phone call from an occupant on the ninth floor that smells smoke. The time is 0430 hours. The date is August 12th.

Observed Upon Arrival

The lobby is full of occupants in nightclothes. They are milling around and do not want to go outside. The annunciator panel is lit up from floors 4 through 16 now. There is no smoke or fire showing outside yet. A second-due company advises you of smoke showing from the vestibule on the 8th or 9th floor. The elevators cannot be brought to the ground floors. The stairwells contain a steady but orderly stream of people. The range of reactions by occupants varies from hysteria to an almost calm indifference. The manager cannot be found, nor can the security officer.

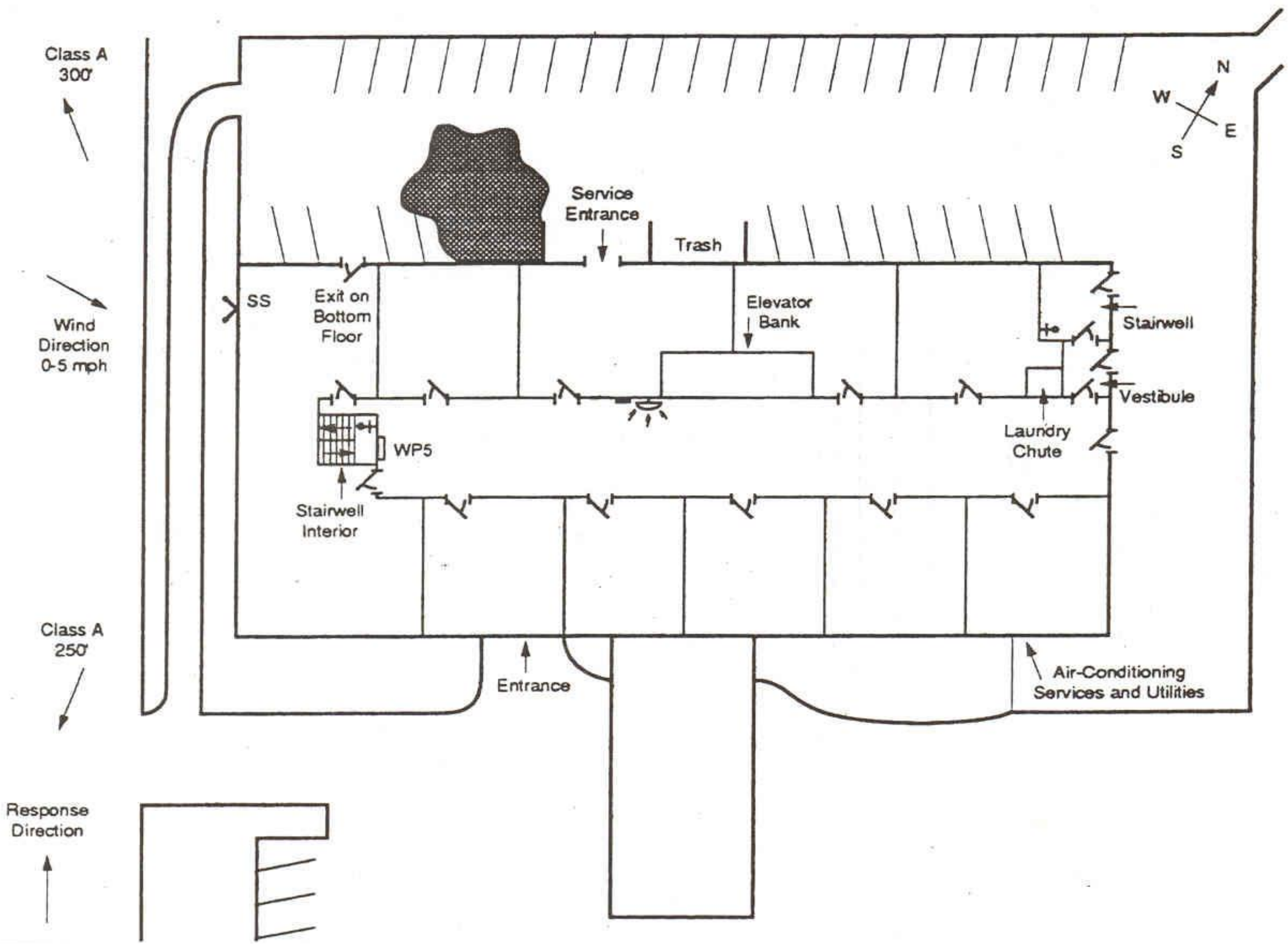
The fire started on the eighth floor, center apartment, and rapidly spread to the hall. An outside window broke and the fire started to lap up the outside of the building. Many windows are open, and a primary concern is that the fire will leapfrog up the outside of the building. The elevators are finally brought to the ground and are used by fire personnel. Because of an error in judgment, they take the crew to the fire floor.

The entire building is never evacuated, not even the eighth floor, because there are sufficient safe-refuge areas on the floors below the eighth floor (not shown on the diagram). The alarm center receives phone calls throughout the fire from occupants requiring oxygen and related assistance.

How Would You Deal With This Problem?

1. Report on conditions
2. Primary objectives

3. Resources needed
4. Plan of attack
5. Placement of equipment and command personnel



6. Potential for escalation

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